# As It Seems To Us

### BIGGER DRILLS FOR ROADBUILDERS

THERE is an axiom in sports that a good big man is superior to a good little man. The same comparison holds true of rock drills. Hand-held drills of the "Jackhamer" type are indispensable in certain places, and they, alone, are suitable for many applications. Sometimes, however, conditions and materials to be excavated are such as to permit a choice between "Jackhamers" and larger, mounted drills. In such cases the mounted units will often prove the more effective.

Ever since they became available, hand-held drills have been almost universally used in road construction. Recently, though, certain wide-awake contractors have discovered that the heavier, mechanically controlled wagon drill will sometimes make an easy drilling job out of one that it would be extremely difficult to do with "Jackhamers." As a matter of fact, the advantages of the larger unit are frequently so pronounced that the roadbuilder, if he compare costs, would find that he could not afford to use hand-held drills.

It goes without saying that few contractors will consciously choose from two pieces of equipment the one of lower effectiveness. Given the facts, they are quick to select the best tool for the job. The wagon drill is relatively little known among highway builders, however, and the majority of them are unaware of what it will do. Because of these things, an article on a road-construction job in West Virginia presented in this issue should make interesting and profitable reading for road contractors.

### GOLDEN GATE BRIDGE

GROUND-BREAKING ceremonies on February 26 marked the formal beginning of construction of the Golden Gate Bridge at San Francisco, Calif. The bridge and its collateral works will cost approximately $35,000,000 and will require four years to complete. Inauguration of actual work brings to a realization plans which have been in the making for 50 years. The present movement had its inception in 1922, when M. M. O'Shaughnessy, city engineer of San Francisco, asked Joseph B. Strauss of Chicago, Ill., to make a study of the project. Mr. Strauss subsequently was named chief engineer of the district which was formed to sponsor the undertaking. As advisors, he was given such eminent bridge builders as O. H. Ammann and Leon S. Moiseiff, of New York City, and Charles Derleth, Jr., of Berkeley, Calif.

The bridge, itself, will be a prodigious creation. Its central suspension span of 4,200 feet will eclipse by 700 feet that of the present record holder, the George Washington Bridge across the Hudson River at New York. The cables which will support it will be 36½ inches in diameter, another record dimension. Each cable will be made up of 25,572 wires, each one-fifth inch thick. Similar figures might be cited, most of which will set new marks in bridge construction. They must be given the weight to which they are justly entitled, but it is only fair to remember that when the Roeblings built Brooklyn Bridge they laid the engineering foundation for succeeding structures, each of which outdid the last previous effort.

The Golden Gate Bridge, with its approaches, will constitute a 7-mile thoroughfare. It will link coastal highways which have hitherto by-passed San Francisco, and will relieve that city of its peninsular isolation. The bridge will be operated on a toll basis which is calculated to amortize the investment in 25 years. The structure will have a carrying capacity of 260,000 vehicles each 24 hours, which is 40 times the estimated traffic that will use it during the first year it is open. As befits such an outstanding piece of construction, the bridge will be given pleasing architectural treatment.

### OUR COVER PICTURE

THE pine tree which we show on our front cover is one of the most photographed growing things in the United States. It is rooted in solid rock and occupies a scenic and accessible spot in Rocky Mountain National Park, Colorado.

### ROCK-DRILL LUBRICATION

ONE of the great problems in connection with securing maximum effectiveness from rock drills has always been the difficulty of insuring adequate lubrication for the machines. As the operating speeds of drills increased, the problem grew apace. In today's drill, the piston shuttles back and forth at the astounding rate of from 1,600 to 2,200 times a minute. It is self-evident that the amount of rubbing of metal against metal which this entails induces a wearing action that will ultimately efface even the most highly resistant material. To complicate matters, compressed air contains a considerable volume of water vapor which condenses when the air cools upon expansion in the tool, and this water tends to wash away the lubricant.

Regardless of the system of oiling that is used, the drills will run without lubricant unless somebody remembers to supply oil to the proper reservoir periodically. In most cases this chore rests with the drill runner, and he is notorious for his theory that it is wrong to pamper such a brutish machine. He runs it as long as it will respond to his efforts, and then turns it over to the "drill doctor."

Recognizing this frailty, or stubbornness if you prefer, in human nature, managers of South African mines have hit upon an idea which they hope will serve as a reminder to the men that the drills need oil. Eucalyptus oil, in the proportion of 1 part in 128, is added to the lubricating oil. As long as the pleasant, penetrating odor of eucalyptus comes from the exhaust, the miner knows that the drill is being lubricated. When it ceases, he has his warning that he should renew the oil.

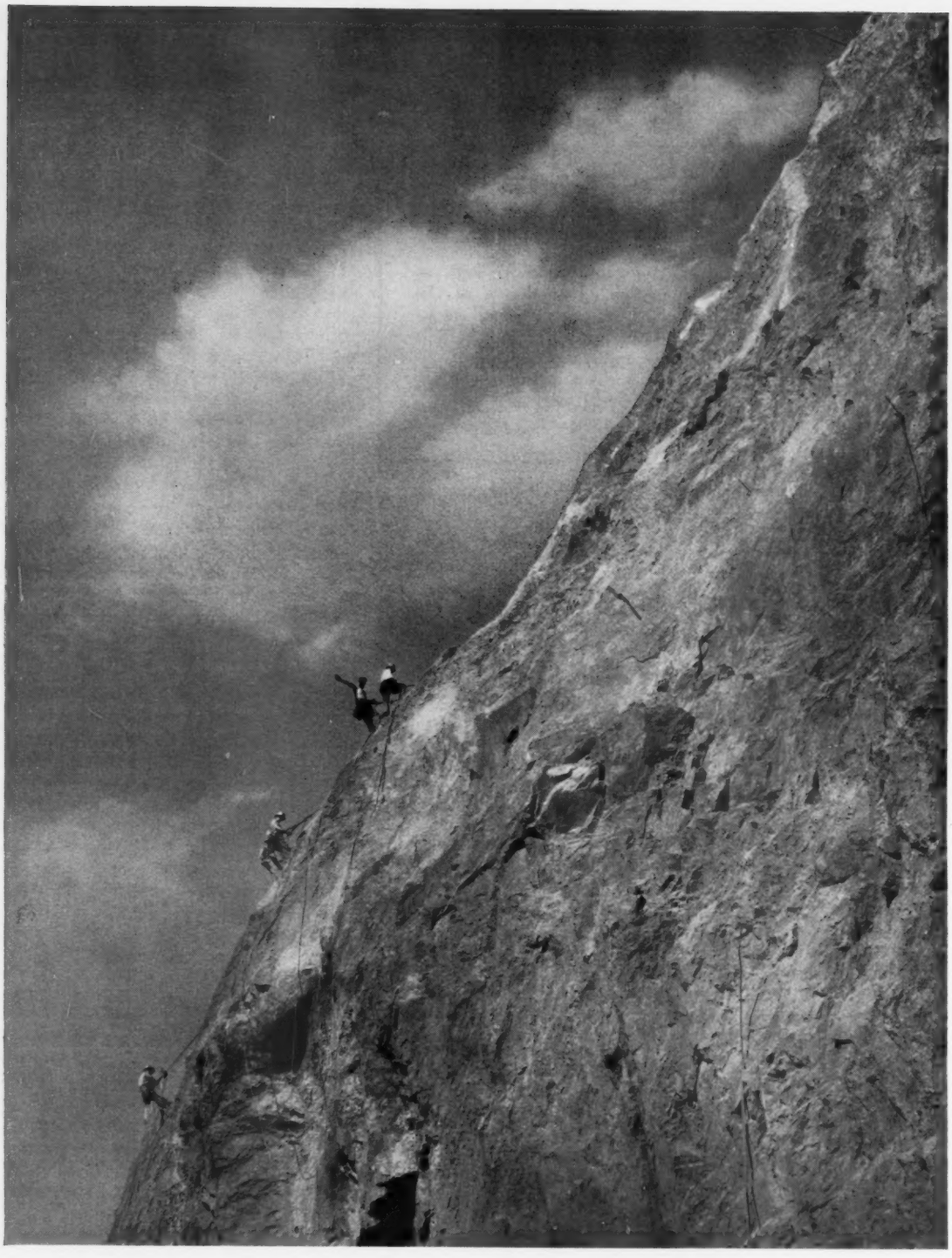
Commenting upon this expedient, MINING AND METALLURGY well says: "The scheme is ingenious, but it would seem wise to withhold judgment until results in practice are available. Even if his olfactory nerve is sufficiently sensitive, the hard-rock miner is an *hombre* who hates to 'waste' time so long as 'she's cuttin' all right."

### ENCOMIUM

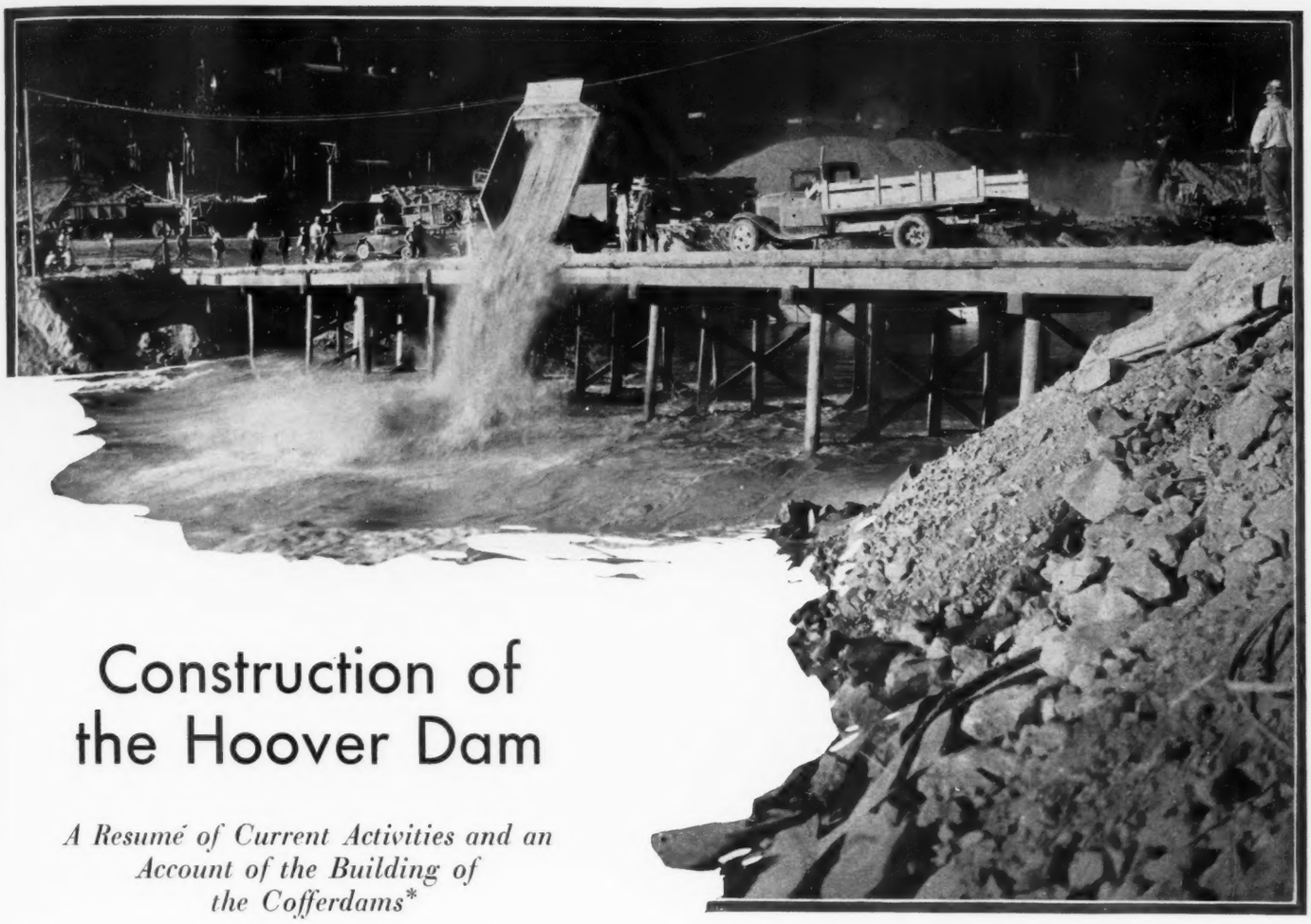
IT IS a well-established fact that the trade journal occupies a definite place among American publications. It persists because it does a necessary job. It conveys authoritative information; it serves as a clearing house for ideas; it enables busy men to keep posted on important happenings and developments in their particular fields of endeavor; it acts as a convention; it is a round-table discussion.

Perhaps one of the real reasons why these journals continue to find a place in the curtailed scheme of things is reflected in the remarks made by S. Ward Seeley of the editorial staff of N. W. Ayer & Son, Inc., one of the world's foremost advertising agencies. Speaking recently before the Technical Publicity Association in New York City, Mr. Seeley traced the changes for the better that have marked the editorial columns of trade publications during the past twenty years.

"Where once the trade editor's chief tools were scissors, paste-pot and pencil," he said, "today they are the railroad ticket, the Gladstone bag and the press telegram. Where once editors punched time clocks, today publishers announce with pride that you can seldom find their editors at their desks. Where once it was a chore to extract from the pages of these publications the little value they contained, today they are easy to read and are eagerly consulted."



*HIGH scalers at their perilous work of stripping loose and projecting rocks from the walls of Black Canyon. Suspended by cables, these workmen accomplish their task with "Jackhamers" and duralumin pinch bars.*



# Construction of the Hoover Dam

*A Resumé of Current Activities and an Account of the Building of the Cofferdams**

WESLEY R. NELSON†

**Hundreds of tons of rock were dumped from a trestle bridge last November to form a temporary diversion dam.**

A BLAST at the inlet of Diversion Tunnel No. 4, half an hour before noon on November 13, 1932, turned a portion of the turbid Colorado River from its natural course into a man-made by-pass through one of the walls of Black Canyon and signified the completion of the first stage of the construction program which will ultimately conserve the wasted energies of the stream and employ them in the development of the Southwest. This initial diversion of the river around the site where Hoover Dam will be reared marked the successful termination of most of the preparatory work—the principal exceptions being the cofferdams upstream and downstream from the dam site. It likewise indicated the commencement of many phases of the permanent structures.

Previous articles in this publication have described the adequate railroad and highway systems that connect the working zone with trunk lines and related how the modern construction camp of Boulder City was developed from waste desert land to a community of 1,000 homes and 5,000 population within scarcely a year. Others have portrayed the adequacy and magnitude of the plants and equipment installed by Six Companies Inc. to expedite construction and told of the revolutionary measures by which 1,500,000 cubic yards of rock was removed from three miles of 56-foot-diameter tunnels in one year and a 3-foot lining of concrete placed in them in a similar period by the pouring of approximately 370,000 cubic yards of concrete.

The same dispatch and care with which the preliminary operations were completed is in evidence today in the work in progress. The 600-foot-long inclined tunnel from the Nevada spillway channel to Diversion Tunnel No. 1 has been enlarged from a 7x14-foot top heading to an opening with an average diameter of 56 feet in about 125 days, during which time nearly 50,000 cubic yards of rock has been moved. Approximately 80 per cent of the required excavation has been shot out of the canyon walls in the cuts for the 30-story, 75-foot-average-diameter, concrete intake towers through which water will flow from the reservoir to outlet works or to turbines in the power plant.

Loose and projecting rocks are being pried and blasted from the canyon walls as a precautionary measure—rocks that might otherwise fall on structures while being built or after construction. This work is being done by high scalers, suspended by long ropes, who dislodge the loose bowlders with duralumin pinch bars, remove the fine material with compressed-air or water jets, and drill and blast away the more solid and protruding rock until the cliff presents a relatively smooth and even slope.

Other work in progress includes the driving of penstock tunnels, of an inclined raise to the upstream intake-tower site, and of a 26x43-foot construction adit—all from the Nevada diversion tunnel nearer the river. A shelf has been cut on each canyon wall for outlet works; tunnels are being driven inward from these; and from points near the outlet works have been started 26x43-foot construction adits which will lead to the pressure tunnels. From these connections the pressure tunnels will be driven upstream toward the sites of the downstream intake towers. Stoney gates, 50x35 feet in vertical-plane dimensions, are under erection at the outlets of the two diversion tunnels closer to the river, and 50x50-foot steel bulkheads are being placed at the inlets of the tunnels farther from the river. Each huge bulkhead, complete with its steel frame and cylinders, weighs over 3,000,000 pounds, and required 42 railroad cars for transportation to the proj-

†Assistant Engineer, U. S. Bureau of Reclamation, Boulder Canyon Project.

*Thirteenth of a series of articles on the Colorado River and the building of Hoover Dam.

**Right—Half the stream bed inclosed by a dike to permit an early start on the upstream cofferdam.**

**Center—Inlet portals of the Arizona tunnels after the initial diversion of the river.**

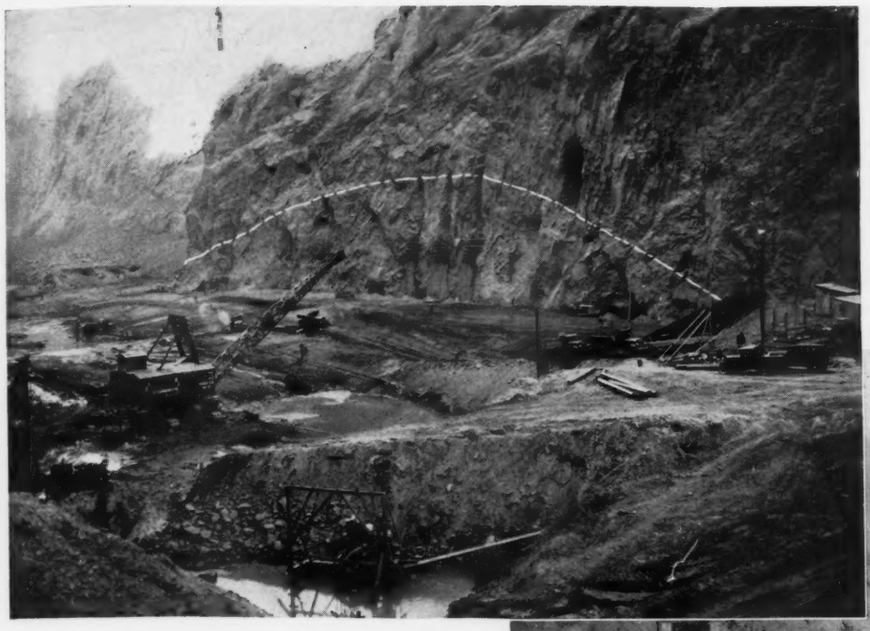
**Bottom—Looking upstream after the diversion at the area in which Hoover Dam will take form.**

ect. Eminently important at the present time, owing to the menace of spring floods, is the construction of two diversion cofferdams that will maintain the flow of the river through the diversion tunnels and provide a dry site on which the main structure of Hoover Dam will be built.

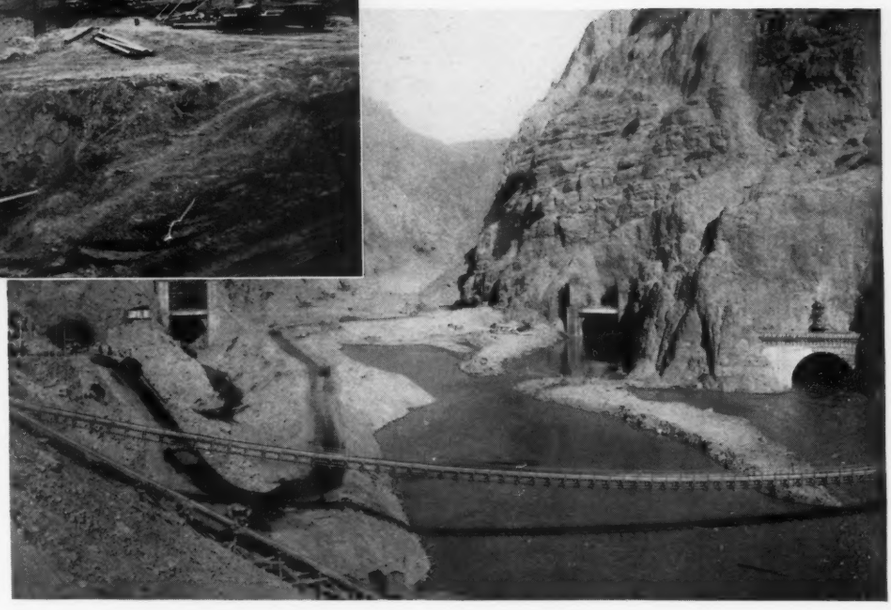
As is shown in accompanying illustrations, the upper cofferdam is an earth fill. The upstream face is protected by 6-inch reinforced-concrete paving laid on a 3-foot thickness of rock blanket, and the downstream face is covered by a heavy rock fill. The slope is 3 to 1 on the upstream face and 4 to 1 on the downstream face. A cut-off of steel sheet piling at the upstream toe rests on bedrock and is joined to the face paving by a concrete wall and rubber seal. A puddled-clay fill and a rock blanket protect the connection.

A rubber seal is also placed at each junction of the face paving and canyon wall and extends the full width of the paving from the steel piling to the crest of the dam. A ledge for this connection is cut in each canyon wall contiguous to the face paving and on the ledge is built a concrete curb with a 4-inch space between it and the paving. A 36-inch width of tire fabric, ¼ inch thick, is folded down into this space—the edges of the fabric being fastened to both curb and paving. Thus any settlement of the dam or other movement in the face paving will not break the seals between the dam and the canyon walls.

Three reinforced-concrete percolation stops, resembling thin counterforts, are poured near the center of the dam where it contacts with the canyon walls. Channels 3 feet deep are cut into the cliffs from base to crest, and concrete is poured to form piers of 2-foot basal thickness, approximately 8 feet across the sides, and 98 feet high. The percolation stops extend at least 5 feet into the dam fill and prevent the free flow of water along the plane



**Left—Site of the upper cofferdam, with the contour of the structure painted on the canyon wall.**



**Below—A view upstream on January 6, 1933, showing water emerging from the Arizona diversion tunnels.**

between the cliffs and the dam.

The upper cofferdam is 98 feet high, 480 feet long, and 750 feet thick at the base. More than 500,000 cubic yards of earth and gravel, 151,000 cubic yards of rock, and 3,500 cubic yards of concrete were required for its construction. The face paving covers an area of more than three acres and contains 5/8-inch reinforcing material, on 15-inch centers both ways, comprising nearly four miles of steel bars weighing 215,000 pounds. The dam was given these dimensions and features to turn a river flow of more than 200,000 second-feet through the diversion tunnels and to reduce the percolation through the dam to a minimum.

Specifications 519—governing the contract for the construction of Hoover Dam and the power plant and appurtenant works—stipulated for both cofferdams that "the earth fill portions of the cofferdams shall consist of a mixture similar to the natural mixture of silt, sand, and gravel in Hemenway Wash." Other requirements that influenced the contractors' procedure of construction appear in the specifications, as follows:

"No stones having maximum dimensions of more than 9 inches shall be placed in the earth fill embankments.

"The mixture of silt, sand, and gravel shall be placed in the embankment in approximately horizontal layers not more than 12 inches in thickness after rolling. All materials shall be uniformly moistened on the embankment....to such a degree that....the maximum compactness of embankment will be assured after rolling as specified. The roller used....shall be of the 'Rohl' type, having cast iron ball feet equally spaced over its cylindrical surface and its weight shall be not less than 1,000 pounds per linear foot of width of tread.

"The largest rock permissible in the rock fills shall be not more than 1 cubic yard in volume....It is contemplated that material direct from any of the required rock excavation will be suitable.

"The rock in the rock embankments need not be especially compacted but shall be built up by dumping and roughly leveling....such as to insure that the completed fill will be stable, without tendency to slide, and that there will be no unfilled spaces within the fill.

"The upstream slope of the upstream cofferdam shall be covered with a 3-foot layer of ....sound, durable rock fragments or bowlders the maximum dimensions of which shall be not less than 4 inches nor more than 30 inches....The rock shall be evenly distributed or leveled to a roughly uniform layer of the required thickness, on which the concrete paving is to be placed....The method used in placing the rock blanket shall be at the option of the contractor, provided that the method shall secure the required compactness necessary as a foundation for the concrete paving....The contractor shall place any gravel or small rock fragments....necessary to fill the voids in the upper surface of the rock blanket and furnish a suitable surface on which to lay the concrete paving.

"The concrete paving shall be laid in strips not over 16 feet in width running up and down the slope of the cofferdam, and construction joints, across which the reinforcement bars shall be continuous, shall be provided between the strips.

"The rock barrier below the downstream cofferdam shall consist of hard, dense, and durable rock, equivalent in this respect.... to the best rock for resisting wear or erosion that exists in the vicinity of the work, and that may be readily obtained from nearby borrow pits, quarries, or from required excavation. There will be no limit to the size of rock permitted in the rock barrier....The rock may be loosely dumped but in such order and in such a manner as will....insure that the completed fill be stable, without tendency to slide, and so that there shall be no unreasonably large unfilled spaces within the fill.

"Measurements, for payment, of materials in the cofferdams....and rock barrier will be made in place."

Early in September, 1932, an end-dump fill, using muck from the Nevada spillway inclined tunnel, was started from the Nevada side of the canyon and downstream from the inlet portals of the Nevada diversion tunnels. In succeeding weeks the fill was extended to the center of the canyon, thence downstream and back to the Nevada side, thereby inclosing the Nevada half of the upper cofferdam site and crowding the river into the Arizona side of the channel. The inclosed area was pumped dry; a 5-cubic-yard electric dragline was brought down from the Arizona gravel deposit; three 3½-cubic-yard electric

**Blasting away rock for the Nevada abutment of Hoover Dam. The road will cross the crest of the structure.**

**This picture and the opposite one show the finishing operations on the upstream face of the upper cofferdam. The photograph was made January 5, 1933.**

shovels and a fleet of trucks were moved to the site; and excavation of the silt and sand was started to uncover a consolidated formation suitable for the cofferdam foundation. This formation was discovered at elevation 622, at a point 18 feet below the river bed and 98 feet below the dam crest.

Desirable material for the earth fill had been located by test holes in Hemenway Wash. Pits were opened with 3½-cubic-yard electric shovels; railroad track was laid to the pits from the Black Canyon line of Six Companies Inc.; and later the shovels were used for loading the material into 30-cubic-yard side-dump cars for transportation to an unloading site near the cofferdam.

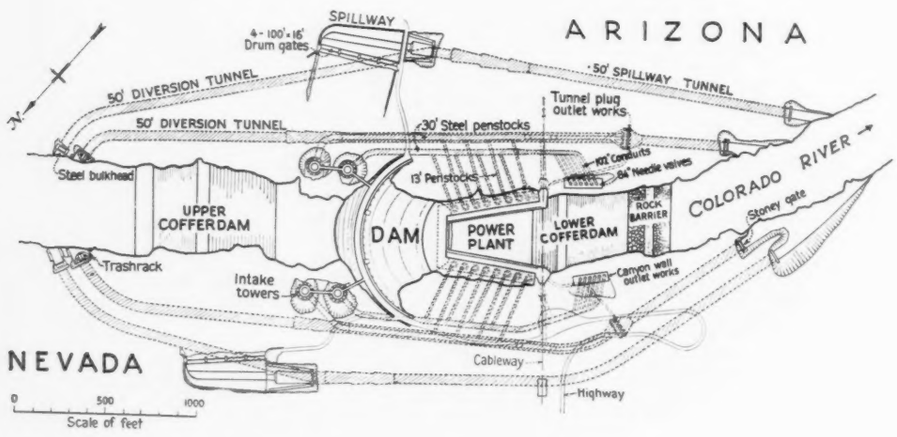
By the time the diversion tunnels were being excavated, a railroad had been built into Black Canyon as far as No. 1 Compressor Plant, half a mile upstream from the cofferdam site on the Nevada shore, and two tunnels had been driven on the continuation of the line—one 1,100 feet in length extending downstream from the compressor plant, and the other 900 feet long extending downstream from the inlets of the Nevada diversion tunnels. The grade elevation of the railroad and the tunnels is 720, the same as the crest of the cofferdam.

A fill was then built along the river's edge from the compressor plant downstream to a location just upstream from the inlets of the Nevada diversion tunnels; a single-track line was laid on the fill outside the 1,100-foot tunnel; and double tracks were run from near the lower portal of this tunnel to the cofferdam. The track closer to the river was extended by a pile trestle bridge to a point downstream from the diversion-tunnel inlets, providing a structure for unloading fill material brought from Hemenway Wash. A loading platform was constructed on the canyon-wall side of the other track for removing the silt and sand transported from the cofferdam excavation by 8- and 10-yard trucks. This rejected material was used for widening the railroad bench along the river or was unloaded at a dump ground near the mouth of Hemenway Wash.

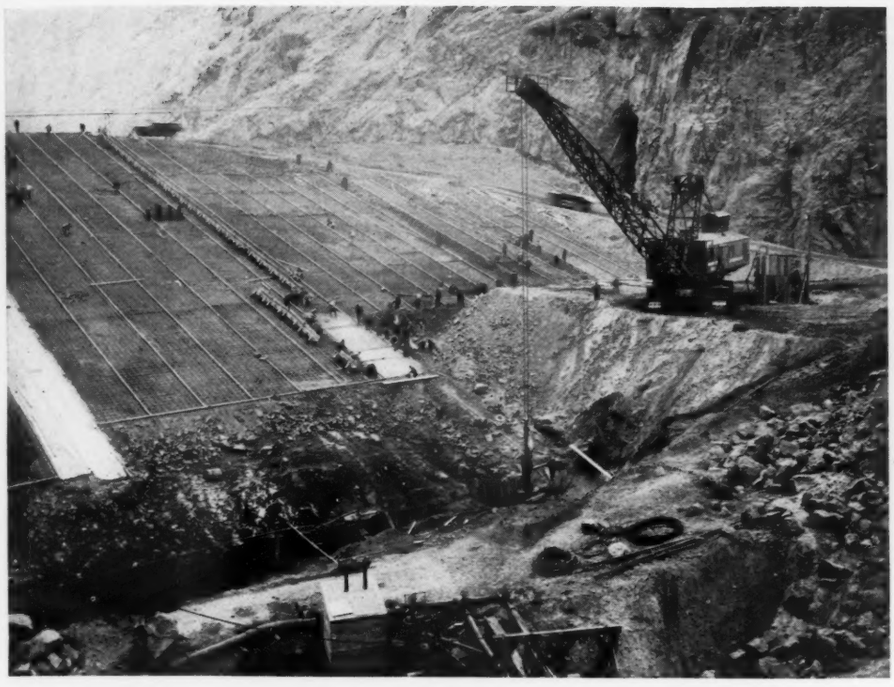
The material from Hemenway Wash was dumped from the trestle by side-dump cars, loaded into trucks by two 3½-cubic-yard electric shovels, and moved to the cofferdam fill. There it was dumped by the trucks; spread by bulldozers mounted on 60-hp. Caterpillar tractors; the correct amount of water sprinkled on the material; and the mixture rolled by 6-ton Rohl type rollers pulled by 30-hp. Caterpillar tractors. When excavating for the cofferdam was in progress, the trucks that hauled the fill material also proceeded to the site of the excavation and there received the loads of silt and sand which they took to the loading platform and dumped into the waiting railroad cars.

A pile trestle bridge had been built across the river downstream from the inlets of the diversion tunnels, and as soon as the blast removed the barrier in front of Tunnel No. 4, allowing water to flow through it, trucks commenced hauling rock and dumping it into the river on both sides of the bridge. Within 30 hours after the initial diversion, the temporary dam thus constructed had risen high enough to cause all except a small amount of water seeping through the hastily constructed fill to flow through the Arizona diversion tunnels. To cut off the seepage and to prevent inundation of the cofferdam site by a possible river flood, the temporary dam was heightened and widened, using muck from the cofferdam excavation.

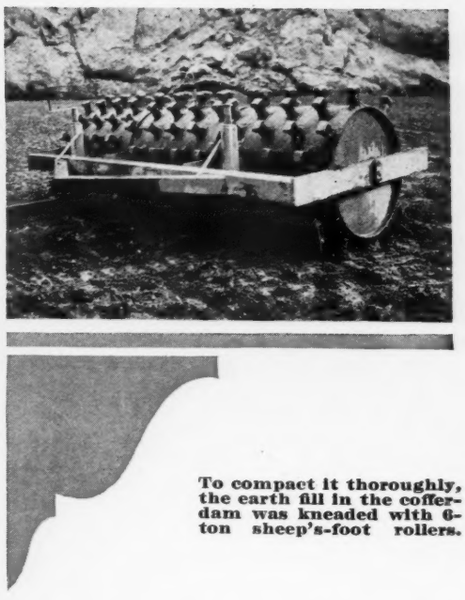
Soon after this temporary dam was completed above the upper cofferdam, a similar




**Plan drawing of the principal structures involved in the rearing of Hoover Dam.**



**Concrete is being laid in longitudinal sections. At the right a dragline is handling a hammer which is driving steel sheet piling with compressed air.**



**To compact it thoroughly, the earth fill in the cofferdam was kneaded with 6-ton sheep's-foot rollers.**

fill was placed immediately upstream from the outlets of the diversion tunnels. The water in the river channel thus inclosed was pumped out, and excavations for the upper cofferdam were extended to the Arizona wall. The work was started on September 25 and finished on December 5, during which period 212,872 cubic yards of sand and gravel was removed at the average rate of 5,200 cubic yards a day.

Because of the existence of a number of large bowlders along the line of the upstream toe of the cofferdam on the Nevada side, the steel sheet piling was placed on a concrete footing, set on bedrock, for a distance of 120 feet out from the canyon wall. Along the remainder of the cut-off line the piling was driven by a McKiernan-Terry No. 9-B-2 hammer operated with compressed air. Ordinarily, the hammer was spotted and held in driving position by the 5-cubic-yard dragline. The piles are 16 inches wide, from 40 to 55 feet long, and are of the arch-wedge type, which has a continuous interlock rolled integral with the pile for its entire length. The 80-foot boom of the dragline was used to advantage in getting the piling in position.

The percolation stops were formed and poured as the fill progressed upward. The concrete required was hauled from the mixing plant by 10-ton trucks in 4-cubic-yard agitators; and the 5-cubic-yard dragline was used as a crane in lifting the agitators from the trucks to the pouring site.

The rock blanket on the upstream face and the rock fill on the downstream face were placed after the earth fill was practically completed. The material was secured principally from rock shot down from the canyon walls during the stripping operations or from the excavations for the intake towers.

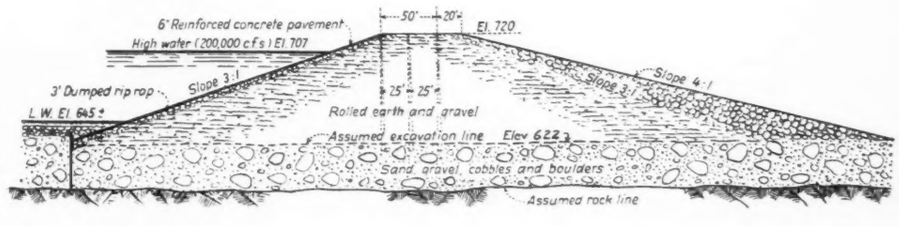
The face paving was poured in 16-foot sections running from the concrete curb at the sheet piling to the crest of the dam. Paving was started on December 20, 1932, and at the end of January, 1933, was approximately 50 per cent completed. The ledges were cut in the canyon cliffs and the concrete curbs poured after the earth fill was finished.

Work on the earth fill was begun on October 31, 1932, and finished January 1, 1933. It contains approximately 510,000 cubic yards of material, of which 420,000 cubic yards was placed in December. On many days in that month as many as 4,000 truck loads, or 18,000 cubic yards of material, were deposited in the fill, using three 3½-cubic-yard electric shovels at the pits and two or three shovels of the same capacity for loading the fleet of 35 trucks. For hours at a stretch, each shovel was loading, swinging, and dumping a shovelful in less than 30 seconds.

Construction of the lower cofferdam and rock barrier has been delayed by reason of the scaling of the canyon walls, making the site for the time being impractical of access. The rock barrier will consist of a fill of 100,000 cubic yards of rock. It will have a height of 54 feet, a length of 380 feet, a thickness of 210 feet at the base and of 50 feet at the crest, and slopes of 1½ to 1 on each side. Its foundation is at approximate elevation 629, or 11 feet below the river bed.

The earth fill upstream from the barrier, although smaller, is similar in design to the upper cofferdam and calls for essentially the same procedure of construction. There are, however, no sheet-piling cut-off walls and no downstream-face covering or seals at junctions with the canyon walls; but, as in the case of the upper dam, two percolation stops will be provided on each side, and the upstream face will be covered with a heavy rock fill. It is estimated that the dam will contain 230,000 cubic yards of earth and 63,000 cubic yards of rock. It will be 360 feet long, 66 feet high, and range in thickness from 500 feet at the base to 50 feet at the crest. It will rise from a foundation elevation of approximately 624. The downstream slope is to be 5 to 1, and the upstream slope 2 to 1.

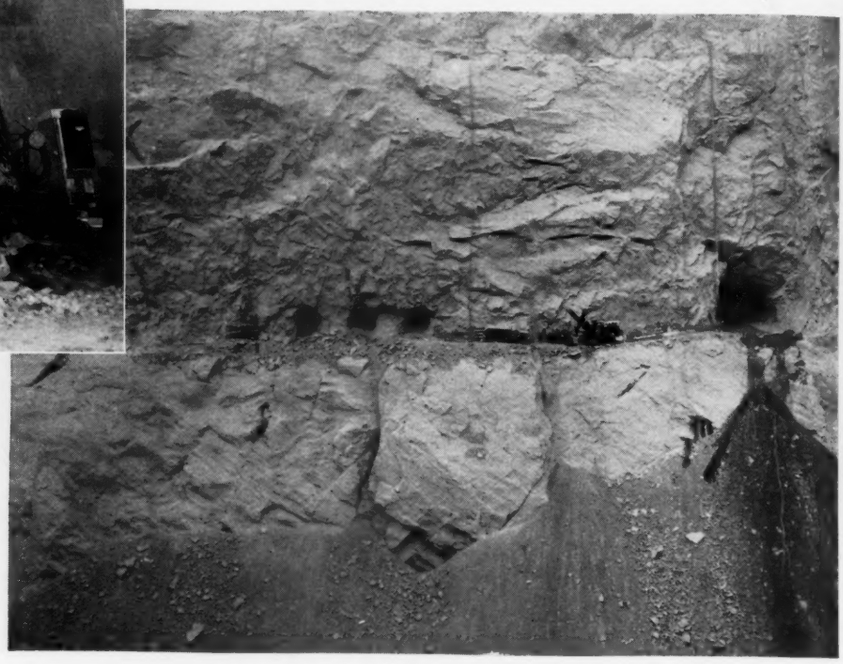
By February 1, 1933, the rock-barrier site had been excavated and 80,000 cubic yards of rock deposited for its construction. Very little work had been done up to that time on the lower cofferdam, but plans had been made to secure the earth fill from Hemenway Wash. This material will be hauled by railroad through the two long tunnels, dumped from a trestle near the main dam site, and loaded by power shovels into trucks for transportation to the cofferdam site.




**Cross section through the upper cofferdam showing the character of construction.**

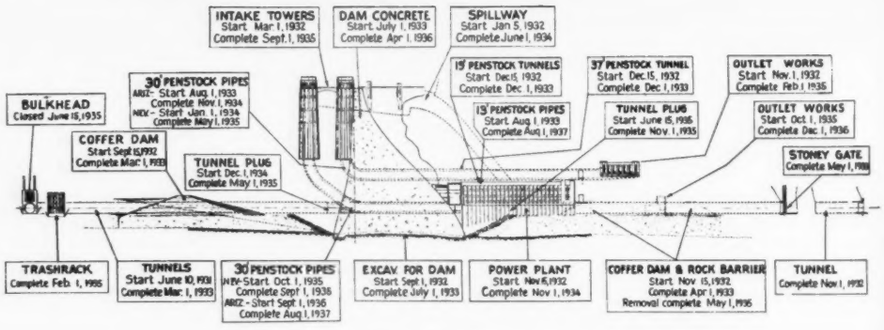
**Left—Starting a 21-foot penstock tunnel from the interior of one of the 56-foot diversion bores.**

**Below—Outlet tunnels and (at the right) a construction adit being started from a shelf on the Nevada cliff.**



Both cofferdams and all four diversion tunnels are expected to be completed before the high-water period of the coming spring and summer. Advantage was taken of the low flow of the Colorado River in constructing the upper cofferdam, the discharge during the months of November and December never having gone above 7,500 cubic feet per second. Flash floods of 50,000 cubic feet per second may occur in any month of the year, as happened in February and September of 1932. The greatest flow of the river is expected in May or June, when the discharge may exceed 200,000 cubic feet per second.

Eventually, when the bulkhead gates are closed at the inlets of the diversion tunnels, and when the flow of the river is controlled by the slide gates installed in the upstream plugs of the other two tunnels, the upper cofferdam will be overtopped by the waters of the Colorado and inundated by the reservoir back of Hoover Dam. The lower cofferdam and rock barrier will be removed from the river channel at about the same time, probably in 1935. The removal of these downstream fills is necessary to clear the tailrace for the efficient operation of the power plant.




**A recent Bureau of Reclamation diagram which shows the program of construction.**

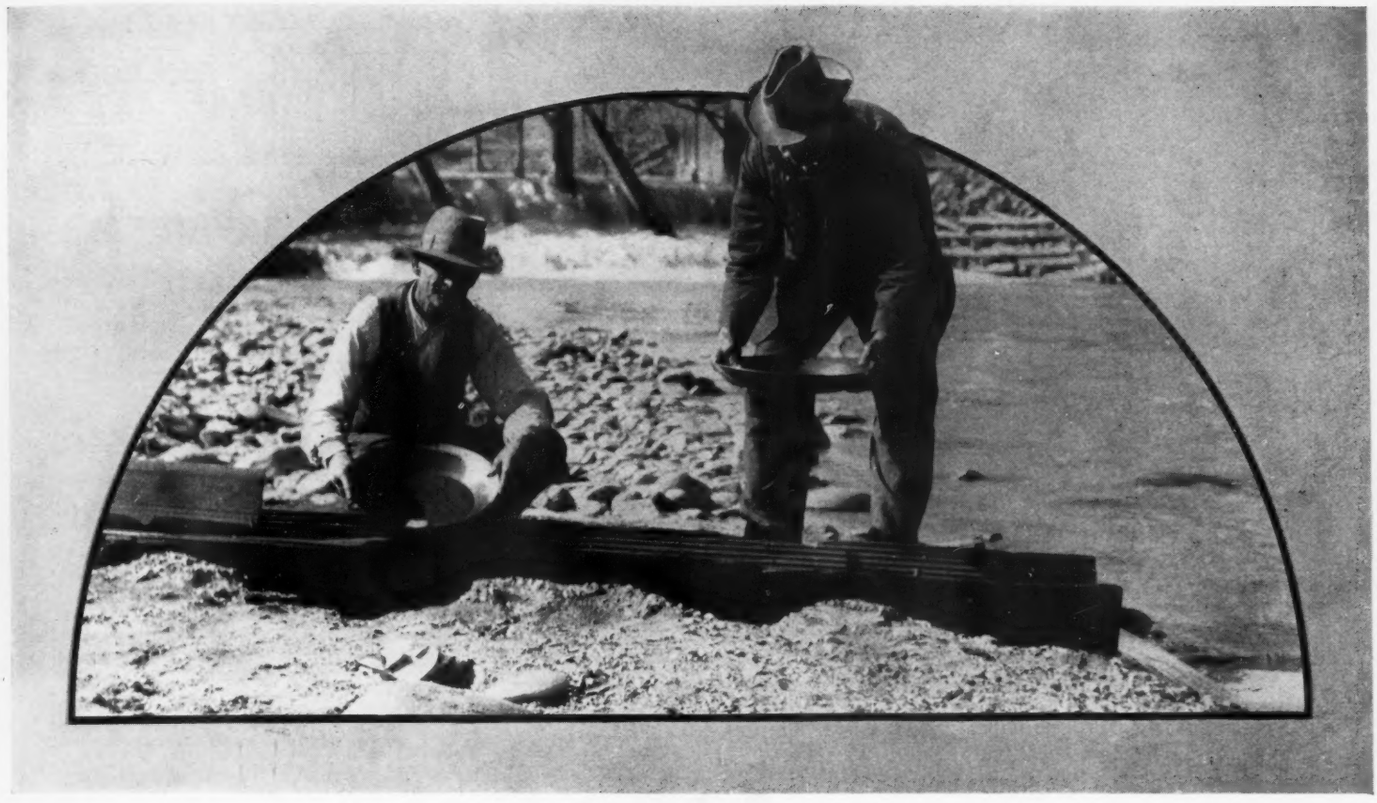
## BENTONITE REVEALS MOTHER EARTH'S AGE

THE MINERAL bentonite, a peculiar, compact, fine-grained material, served as Nature's timekeeper when the continents were being formed—a fact which is of inestimable aid to geologists in determining the age of a particular rock series and in correlating various formations in widely separated areas.

Bentonite is derived from the alteration of volcanic ash. Showered from active volcanoes, this ash fell over a wide territory and formed a blanket or layer which effectually divided previously existing formations from those that were deposited later. Thus, when a geologist finds a deposit of bentonite, he knows that he has a time card with which he can accurately measure the relative ages of rocks over expansive areas. Because of their value in this connection, bentonite beds are carefully sought.

Aside from this, bentonite is of considerable commercial importance. It has marked powers of absorption and, because of this property, is a favored material in the manufacture of paints, fertilizers, paper, and the like, as well as in the refining of crude oil. It is also employed in such medicinal preparations as "Denver Mud" and antiphlogistine, and as a filler in phonograph records, textiles, and other commodities.

Most commercial bentonite comes from the western states. That found in the eastern half of the country is of greater geological age and has been compressed to such an extent that its absorptive power has been decreased. The existence of beds east of the Mississippi River was not known until 1920, but since then bentonite has been discovered in eight of those states. Mr. R. R. Rosenkrans, of Pennsylvania State College, has recently succeeded in finding twelve beds in central Pennsylvania and has been able to trace them over an area 150 miles long and 40 miles wide. They vary in thickness from 1 to 10 inches.



**Men panning concentrates taken from the riffles of the sluice in front of them.** Courtesy Colorado Association

# Tilling the Sands for Gold

*The 1933 Placer Miner Uses the Same Types of Equipment that Served the Argonauts of 1849*

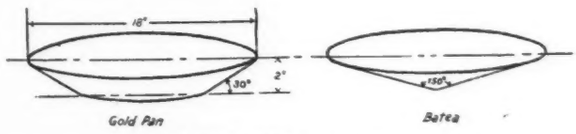
ALLEN S. PARK

THE depression-fostered gold rush that has sent thousands of men to the hills in the mining regions of the United States and Canada shows no signs of abating. In fact, it is virtually a certainty that the army of prospectors and panners will be larger this year than ever before. The work is hard, and the returns that may be reasonably expected are far from alluring; but gold is still worth $20.67 an ounce, and there is a ready market for all of it that can be found.

In many respects, this modern quest for the yellow metal is like that of 1849. Relatively few of the gold seekers are trained in the technique of locating or recovering the object of their search. Most of today's Argonauts are city folk—ex-businessmen, clerks, and industrial workers who have turned to their new vocation through necessity. Only a small percentage of those who take to the open spaces have had previous mining experience. Recognizing this, many state departments of mining, various civic associations, and other agencies have set up classes for the free instruction of the novices. More than 400 persons enrolled for such a course conducted by the Ontario Department of Mines at Toronto in January. Last summer, at Denver, embryo one-man mining concerns were given laboratory training in the panning of gold in the gravels of Cherry Creek, a stream that the pioneers of 1859 tramped in hordes. Newspapers in mineral-bearing sections have contributed space for question-and-answer columns, and have referred queries from men in the field or about to go there to competent authorities—usually members of the faculties of local mining-engineering colleges. Information on how to find and recover gold seems to be almost as much sought after as the metal itself.

The similarity between the present and past gold rushes is particularly noticeable with regard to the kind of equipment used. Scores of mechanical contrivances for recovering gold from sand and gravel deposits have appeared on the market, and many of them are practical; but relatively few persons can afford to spend even the moderate amount of money that they sell for. The 1933 model of gold seeker, like his forbears, depends essentially upon simple, inexpensive implements and equipment; and his own muscles constitute his power plant.

Because the romance of a previous glittering era has been associated with them, and because they continue to be the chief reliance of the men who churn the gravels of stream beds and who tramp the hills hunting quartz lodes, these tools and methods hold an interest which warrants a brief description of them. Already the demand for knowledge of how to make and use them has prompted several state mining departments to compile and distribute information of this sort. Most of them are so simple that they can be built by anyone, and it is undoubtedly partly to this virtue that they owe their continuing popularity.

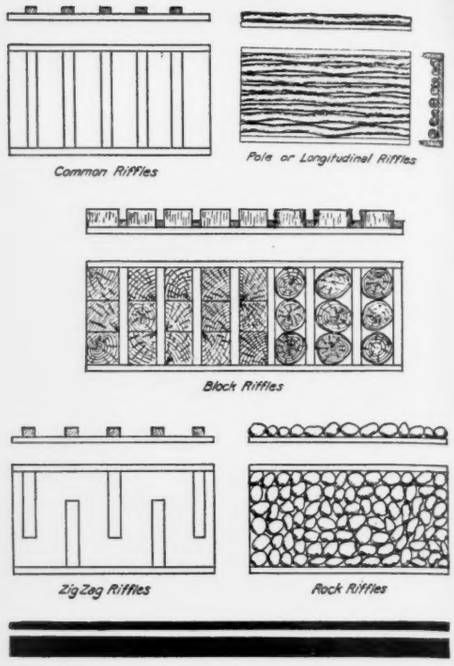



**The gold pan and "batea" compared.**

The simplest and most universally used device is the gold pan. In essence, it is a large frying pan without a handle. The initial discoveries of gold in California in 1848 were made by men who had no conception of mining and who were engaged in other pursuits. James Marshall, who start-

Courtesy Colorado Association

**Gold diggers shoveling gravel into the head end of a sluice. From an old photograph.**




**Riffles are placed in the bottoms of sluices to capture the particles of gold. Many kinds of riffles are used. Some of the popular ones are shown.**

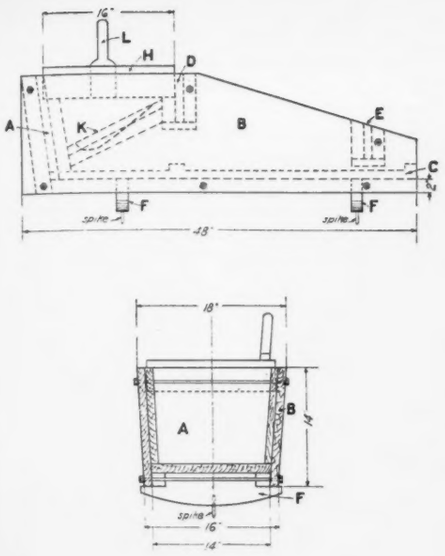
ed the rush by discovering yellow flecks in the tailrace of the water-powered sawmill he had just built, was a wheelwright from New Jersey. His partner in this venture, John A. Sutter, was a Swiss adventurer and merchant. Among the five white men and three Indians that constituted the working force, only the Indians had ever seen gold in its natural state. Few of those who swarmed into the section when the news of the strike spread about the country brought with them any mining equipment. The most satisfactory concentrating vessel available to everyone was the frying pan, and it proved so well adapted to the process that few changes were made in evolving the gold pan from it. Even today many prospectors make the blackened skillet do double duty. They are careful, though, to scour its inner surfaces free of all traces of grease before they use it for panning—a precaution which the pioneers probably didn't know was essential to the successful saving of the precious fragments of the yellow metal.

The modern gold pan is a circular metal dish with sides that slope to a flat bottom. It is from 15 to 18 inches across the top, 10 to 12 inches across the bottom, and from 2 to 4 inches deep. It is ordinarily formed of heavy-gauge steel, and the rim is turned back around an encircling wire to stiffen it. It weighs from 2 to 3 pounds. Pans for the amalgamation of gold with mercury are of copper or have copper bottoms. The *batea* is the Mexican equivalent of the pan, and was in use long before white men prospected the stream bottoms of this country. The sides of the *batea* converge to a point, giving it the shape of an inverted cone. This utensil was first made of wood, but is today sometimes fashioned of metal. Many prospectors hold that wood arrests fine particles of gold that are difficult to retain in a metal pan. A shallow wooden chopping bowl such as every housewife possesses can be used in lieu of a *batea*.

The following directions for the correct use of the gold pan are abstracted from a report of the State Mineralogist of California, published by the California Division of Mines: "The object of panning is to concentrate the heavier materials by washing away the lighter ones. To do this most efficiently, all material should be as even of size as possible. The pan is filled about three-quarters full of gravel and is then submerged in water. First the large pieces are picked out by hand and discarded and then the clay is broken up. After these preliminaries, the operator raises the pan to the surface of the water, inclines it slightly away from him, moves it with a circular motion combined with a slight jerk, which stirs up the mud and light sand and allows it to float off.

"This operation of submerging, rotating, shaking, and tipping the pan is repeated several times. Each time, a little more of the sample is floated off, until a stage is reached where only a tablespoonful of material remains and the pan is in a greatly inclined position with the heaviest of the grains in the very bottom. The final step in the process consists of holding the pan, with just enough water to cover the concentrates, with elbows at the side and the pan tipped toward the operator. The pan is then shaken with short, quick strokes, and one side is raised at the same time so that the residue will be spread out evenly in a line or 'tail'."

It is in this tail that the prospector looks for his "colors." With a magnetized knife blade he may remove particles of magnetite. He then examines the remaining material closely, slowly turning and tipping the pan as he does so. Pyrite and chalcopyrite, or "fool's gold," resemble gold from some angles of vision, but change appearance when the light reflection is altered. Gold, on the other hand, retains its color in any position. The concentrates are accumulated until a considerable quantity is on hand, when the gold is ordinarily separated out by amalgamation with mercury in a copper-bottomed pan. Panning can best be learned by watching a veteran, and then practicing until the operations have been mastered. Even a skilled man can pan only from ½ to 1 cubic yard of material in a day of ten hours. Using this laborious process, the returns are small, indeed, unless rich gravels are at hand; and most of the deposits now being worked in this country either have been treated one or more times previously or were passed over by earlier gold seekers as too lean to warrant attention. Because of these circumstances the daily gleanings run as low as 50 cents, and seldom amount to more than $3 or $4. Yet there are thousands of men who are living by the gold




**Essential parts of a rocker. A, end; B, sides; C, bottom; D, middle spreader; E, end spreader; F, rockers; H, screen; K, apron; L, handle.**

© Ewing Galloway

**Father, mother, and daughter form a gold-seeking trio with rocker and pan in Colorado.**

pan in the western part of the country during these times.

To enable him to handle gravel at a faster rate, the early-day gold seeker devised a simple machine. In his *A History of American Mining*, T. A. Rickard describes it as "a wooden box, about three feet long, sloping gently and mounted on rockers, like a baby's cradle. Above the upper end he placed a smaller box, bottomed with wire-screen or sheet-iron in which holes had been punched, this device serving as both a hopper and a sieve to exclude the stones and coarse gravel, which were discharged by lifting the box. To the side of this 'rocker' or 'cradle', as it was variously named, a handle was fixed, so that the digger could move it to and fro with one hand while with the other he poured water over the gravel in the hopper by means of some sort of dipper or can nailed to a piece of wood. Whatever went through the bottom of the hopper fell to the floor of the cradle, the rocking of which expedited the separation of the barren sediment, which was washed away, leaving the gold and iron sand behind."

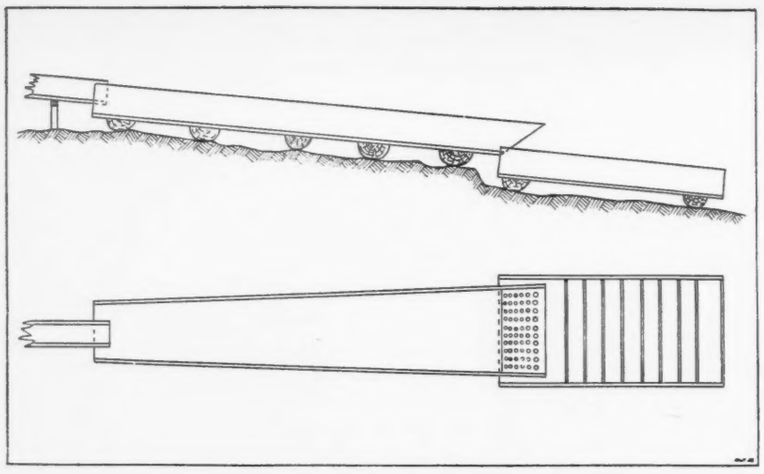
The rocker persists today more or less in its original form, being modified to suit varying conditions, among which the coarseness or fineness of the gold is the most important. It ranges from 24 to 60 inches and more in length, from 12 to 24 inches in width, and from 6 to 24 inches in height. It is customary to place riffles in the bottom to catch the fine gold, and to line it with one of a variety of materials, among which the commoner ones are Brussels carpet, woolen blanket, burlap, canvas, cocoa matting, corduroy, cowhide with the hair side up, sponge rubber, etc. This is held in place by cleats, wire netting, or other means, so that it can be readily removed and the captured metal washed from it into a pan or tub for further treatment. A sloping apron is placed below the screen or sieve to direct the material to the head of the sluice box. It usually consists of canvas stretched loosely over a frame and having a low place in which some of the heavy, valuable minerals are caught. In the bottom and center of each rocker is a spike which fits into a hole in a bedplate, which is merely a plank. By mounting the rocker on two bedplates, one at either end, it is possible to obtain and maintain the correct slope of the box. This slope varies according to the coarseness of the material being worked. If the gravel is fine, the head end will be only about an inch higher than the tail end.

The gravel is shoveled into the screen box and is then washed off by pouring water over it with a dipper. Large pieces are picked out by hand or removed with a forked instrument, and clay is broken up with the fingers. The machine is then rocked vigorously for several minutes, water being poured over the gravel the while. When all material that will pass the screen has gone through it, the box is dumped and refilled. The apron catches the coarse values, and is usually removed and cleaned several times during a day. It is not necessary to clean the riffles so often. The concentrates collected in the rocker are cleaned by panning.

The rocker is a favored device for working gravels in semidry areas, as its water consumption is the lowest of all wet-placer machines. The capacity of a rocker, operated by two men, is from 3 to 5 cubic yards of material every ten hours, the quantity depending upon the character of the gravel and other variable factors. The water requirement is from 100 to 800 gallons per ten hours.

The next and most complex among the manually operated placer contrivances is the "long tom." Its evolution is traced by Rickard as follows: "The rocker served the digger's purpose fairly well, but he ascertained shortly that he was losing the finer particles of gold, whereupon he constructed a machine somewhat more elaborate. He lengthened the cradle until it became a trough or launder eight to ten feet long, and to the bottom at intervals he nailed transverse cleats or riffles to arrest the smaller particles of gold as they slid along with the heavier sediment, while the worthless dirt was washed away by the water that was poured into the hopper."

The long tom as it is used today consists of two sections, a sluice box and a riffle box. The sluice box is generally about 12 feet long. Its width of from 15 to 24 inches at the head increases gradually to from 24 to 36 inches at the tail end. The riffle box is of shorter length and of a uniform width slightly greater than that of the sluice box at its tail end. Both boxes have sides about 8 inches high. The long tom is placed so that it slopes about 1 inch to each foot of length, although this is



**Long tom, plan and elevation.**

varied according to conditions. Water is admitted at the head of the sluice box from a flume or pipe and carries along with it the gravel which has been shoveled into the compartment. The gradually widening box allows the material to spread out in a thinner layer as it is conveyed downward. At the end of the sluice box is a screen or perforated iron sheet which catches the coarse material and prevents it from entering the riffle box. A workman stirs the gravel in the sluice box with a fork and removes the larger pieces after they have been washed clean of adhering fine material. He also periodically cleans the screen and keeps it from becoming clogged. The finer portions are carried through the screen by the water and drop a few inches into the riffle box, where the values are caught. The riffles are frequently augmented by a strip of canvas or other material, and the entire assembly is made conveniently removable for cleaning. The concentrates are usually collected once a shift. It requires from two to four men to operate the long tom. It has a capacity of from 4 to 6 cubic yards of gravel per man in ten hours; but it takes considerably more water than the rocker.

To quote Rickard again: "Finally the elongated cradle, thus developed, was replaced by a series of sluice boxes, or sectional launders, in which the gold-bearing sediment was disintegrated and washed by a stream of water while men on both sides stirred the gravel in the bottom and lifted the large stones out of the runway by means of shovels or forks. In addition to riffles, the digger used blankets, such as those in which he slept, the woolly fiber serving to catch the dust of gold. At a later date he summoned to his aid a chemical agent: he placed quicksilver in his riffles so that the gold was amalgamated, or alloyed, with another heavy metal, which arrested the particles of gold and prevented the minute flakes from running away. The amalgam was collected, put into a buckskin bag, squeezed by hand, so as to discharge the excess of quicksilver, the residue being then exposed to heat, in a retort, whereby the highly volatile mercury was expelled, leaving the gold free."

Sluices of this sort are in wide usage today where enough water is available and where a sufficient number of men band together to work them. It will be seen that more man power is required as we go up in the scale of mechanisms, but that the output per man is correspondingly increased. The pan is the one-man gold-recovery plant—anything more elaborate calls for a community of interests. Depending upon the nature of the material to be washed, the sluice uses from 150 to 600 gallons of water for each cubic foot of gravel treated. In the rocker or the long tom all the coarse material is removed, but in sluicing, as it is practiced nowadays, all but the very large material is carried through the runway by the water. By increasing the slope, the volume of water required can be lessened; but then the quantity of material treated will also be smaller. Various forms of riffles are used in sluice boxes, and sometimes two or more are employed in the same box. Some of these riffles are rather elaborately arranged, and their laying takes considerable time.

Where the topography and the ground formation are favorable, sluiceways may be made by digging a ditch in the surface of the bedrock. No riffles are needed, as the natural irregularities in the bottom provide pockets which entrap the gold. Sluices are often used in conjunction with hydraulic outfits, a stream of water serving both to loosen the gravel and to carry it into the sluiceway. In other instances, the same result is accomplished by merely allowing a stream of water to tumble over the edge of a gravel bank.

There are all sorts of gradations between the rocker, long tom, and sluice, and the equipment to be used is determined by local conditions. It is of incidental interest to note that all these crude gold-recovery devices from the pan upward are in general use on mechanical dredges, where they serve further to concentrate the heavy materials secured from clean-ups.

The gold digger of today may resort to all manner of mechanical agencies—in fact, the list is so long that it would require several pages merely to enumerate them. More than 7,000 of them have been patented, although relatively few have ever got beyond the blueprint stage. The prospector may also have the advantage of various chemicals such as cyanide. It is significant, however, that, by and large, he is using the same types of equipment that were developed 80 years ago during the stampede to California following James Marshall's electrifying discovery of gold in a tailrace.

Special apparatus are required where no water is available. The commonest of these consists of some form of blower to separate the light from the heavy particles by means of an air current. Such equipment is in somewhat general use in desert areas; but the rank and file of the inexperienced gold seekers follow the streams. Here the process is easier to master; the equipment is simpler; the chances for returns are, on the whole, better; and the climatic conditions are far more favorable.

There is a glamour about washing gold or prospecting for it that irresistibly draws many persons to the hills. During years such as we are currently experiencing, it is economic necessity more than natural lure that is swelling the ranks of the gold seekers. In this connection it is well to note that so thoroughly did the pioneers comb the mountains and valleys that no outstanding strike has been made during the past three years, and no instance is on record where a hand-placer miner has obtained anything more than a comfortable living for his efforts. Those associated with mining bureaus are encouraging people to get out of doors, and are teaching them how best to go about the quest for gold; but they are also making it plain to them that they need not expect large returns.

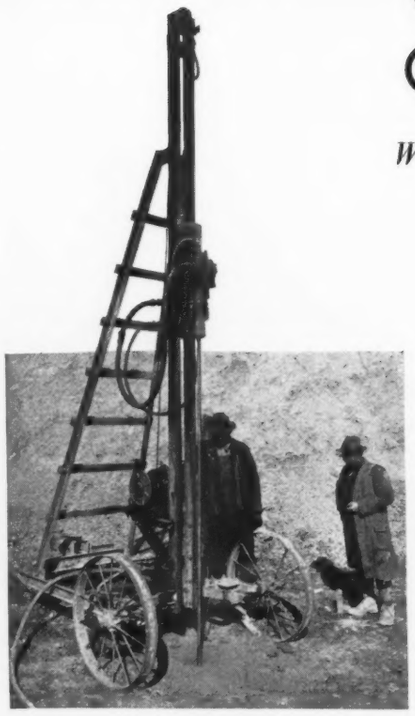
Writing in a pamphlet, which has been widely distributed and from which some drawings and considerable of the material for the foregoing article have been obtained, C. McK. Laizure, district mining engineer for the California Division of Mines, sounds the warning that "the day is definitely past in California when an individual can go out and count on obtaining even day wages by hand-mining for placer gold."

**Study of a gold panner.**

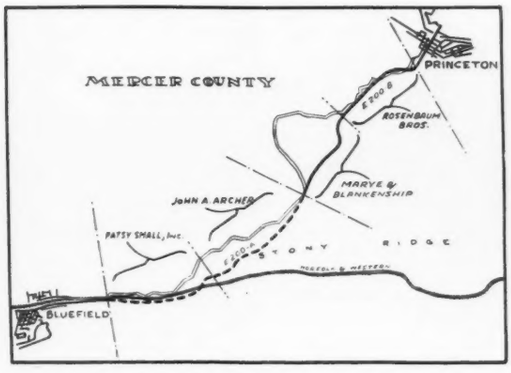
# Wagon Drills Prove Good Roadbuilders

*West Virginia Highway Contractors Discover the Advantages and Economies of this Type of Equipment*

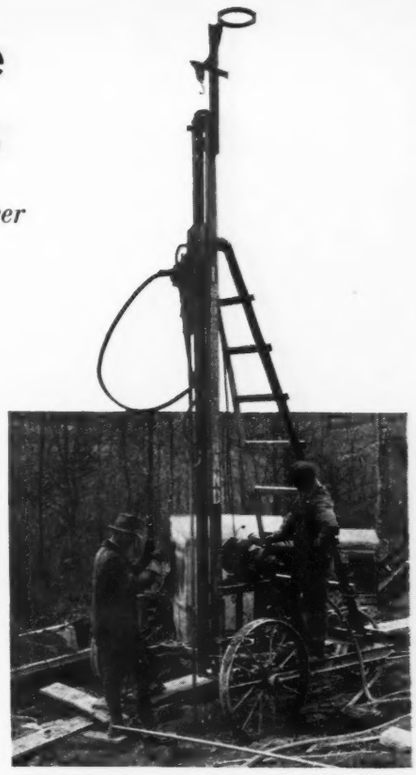
C. H. VIVIAN



A wagon drill working in shale on the contract of Patsy Small, Inc.




The old and new Bluefield-Princeton roads, and the sectional contracts.



Drilling through overburden into rock on the Rosenbaum Brothers job.

AS a stimulus to employment, the Federal Government is advancing funds to the several states for the construction of highways, and there are now underway in various sections of the nation numerous projects which have been made possible by this arrangement of financing. These activities are distinct from the conventional Federal Aid Highway Projects, which are substantially joint enterprises between Federal and State governments. They are known as Emergency Highway Projects, and are carried on under special provisions designed to distribute the resulting work among as many men as possible.

While the creation of jobs is one of the primary objects of these activities, other factors are given due consideration, and the selection of roads thus to be built is based upon the relative need for them. In general, these emergency projects merely anticipate construction programs which would be carried through within a few years in the normal course of events.

Many of the roads thus being brought into service will, in a sense, pay for themselves. The project we are about to describe may well serve to illustrate this point. It consists of a new, paved highway under construction between Bluefield and Princeton, neighboring cities in the southwestern part of West Virginia, and both on a principal interstate route. The existing road is nearly thirteen miles long, and is a winding route with many sharp curves. It calls for careful driving at all times, and, during stormy periods, is apt to be dangerous. The new highway will, in contrast, traverse as direct a line between the two cities as the topography will permit. It will be only 8¼ miles long—shorter than the existing one by more than four miles, or more than 30 per cent. If we exclude two minor curves of 8° and 10°, respectively, it can be said to be without turns. It will be possible to drive over it with safety at speeds up to 55 and 60 miles an hour. Considering the savings in distance and time that it will bring about, it is reasonable to assume that the new route will, on a strictly economic basis, justify the expenditure entailed. Of additional inestimable value will be its effect of largely eliminating the existing accident hazard.

A wagon drill and a power shovel make an effective combination in rolling country.

Anyone who has been in West Virginia need not be told that the work involves the removal of large quantities of material. Mountains are the outstanding topographical feature of the state; and, although they are much lower than those in the western part of the nation, they are so thoroughly and so intricately broken up by erosional valleys that any random line described across country becomes a succession of dips and rises. In most localities the hillsides are steep and the depressions deep. To establish a grade having any semblance of evenness requires cutting through the high spots and filling in the intervening low areas, and these cuts and fills frequently assume large proportions. Rock usually occurs at or near the surface and may be any one of several kinds, and its character may change suddenly and often. These uncertainties complicate a contractor's problems and make resourcefulness a prime requisite to success. Experience with local conditions counts heavily; and it is a matter of record that outside firms lacking this experience are seldom able to build roads there at a profit.

Bluefield and Princeton are of approximately the same

Building a 40,000-cubic-yard fill and, above, truing ends of drill steels with a 4K shank grinder.

This difficult ground on the Rosenbaum Brothers section is being successfully drilled with a wagon drill.

altitude, but the terrain between them presents a very irregular surface. Directness was subordinated to ease of negotiation in establishing the road now used, and this explains its serpentine course. Curiously enough, surveyors for the new route found well-defined traces of an old but ungraded road on the Princeton end that held close to the line of the one they were laying out. This was built during the Civil War and was used as recently as 1912. When population increased, and the rise in commercial intercourse brought heavier haulage, a more circuitous but more nearly level thoroughfare was provided. This winding roadway was widened and improved from time to time, but it remained essentially a travel avenue of the horse age. Sweeping changes in alignment were accordingly made in projecting the new, modern highway designed to meet present transportation conditions.

The Bluefield-Princeton highway is being built under the direction of the State Road Commission of West Virginia, of which C. P. Fortney is chairman. It is officially designated as Project E 200, and this, in turn, is divided into A and B sections. Project E 200-A includes 4.483 miles of line out of Bluefield, and Project E 200-B covers the connecting link of 3.795 miles on the Princeton end. Bids on the two sections were advertised for separately; and of seven bidders on the one and nine bidders on the other, the firm of Brown, Murphy & Wright, of Princeton, submitted the low figure in each case and was awarded the contracts. The work consists of establishing the grade and providing the essential drainage structures. Surfacing of the highway will be done later. The successful bid on Section A was $131,158.25 and that on Section B $99,118.66. The total of $230,276.91 is equivalent to approximately $27,800 per mile, which is indicative of the heavy work entailed.

The joint contract was let on November 7, 1932, and one of its stipulations is that the work shall be completed by June 1, 1933, or in less than seven months. Because of this time element and of certain other considerations, it seemed advisable to distribute the work; and, accordingly, Brown, Murphy & Wright elected to subcontract most of it. The clearing, excavating, and grading were apportioned among four contractors, each of them taking over operations on roughly one-fourth of the line.

The subcontractors, together with the approximate quantity of excavation each is to handle, are: Patsy Small, Inc., Bluefield, W. Va., 180,000 cubic yards; John A. Archer, Ivanhoe, Va., 120,000 cubic yards; Marye & Blankenship, Shawsville, Va., 100,000 cubic yards; Rosenbaum Brothers, Pocahontas, Va., 115,000 cubic yards. All concreting on the entire route was sublet to A. B. Peraldo & Son. The general contractors—Brown, Murphy & Wright, have retained the item of installing corrugated-iron pipe drains. This consists of placing 6,760 linear feet of pipe—4,700 feet of 8-inch, 1,700 feet of 18-inch, and 360 feet of 24-inch.

Active work was underway by December 1, and has been carried on steadily since that time except when weather conditions have made it impossible. Because of the special provisions mentioned at the outset, the project is providing more jobs than is customary in the case of such contracts; and it may be of interest here to enumerate the principal specifications which apply to these Emergency Highway Projects.

Save for supervisors and certain special workers, no man is permitted to work more than 30 hours a week. This necessitates employing two sets of laborers, and has the effect of giving employment to twice the usual force. In this instance, each group works six consecutive days of ten hours each, and is inactive the following week. Minimum allowable wages are 30 cents an hour for unskilled labor and 40 cents an hour for skilled labor. The first-mentioned figure is about one-third higher than the prevailing scale for common labor in the area where the work is being done.

Contractors are required to have as many operations as possible performed by hand labor. Specific provisions relate to this point. It is stipulated that grubbing must be done by hand, except where it involves loosening stumps, when explosives may be used. Other operations to be done manually are: trimming of slopes in cuts and fills; unloading of materials such as pipe, cement, and reinforcing steel; backfilling; and spreading of all material in fills where little or no rock has to be handled.

Men whose names are taken from the certified lists of the County Employment Committee must be given first chance at common-labor jobs, and preference must be shown first to war veterans and next to local, county, or state residents. All pay rolls must be sworn to and filed with the engineer in charge.

**Showing the result of light blasting of well-consolidated shale on the contract of Patsy Small, Inc.**

**A portion of the John A. Archer job and, above, two of the seven Type 20 portable compressors in service.**

They must enumerate the name and address of each employee, the class of work done, number of hours worked, hourly rate of pay, and the county from which his name was obtained. Other provisions limit the charge that contractors may make for board and lodging to 50 cents a day, prohibit the collecting of any fee for giving employment or for the use of tools, and fix the maximum charge for transportation to and from the job at not more than the prevailing rate by bus, railroad, or other public carrier.

Based on the estimated quantities, the material to be excavated averages about 62,500 cubic yards to the mile; and one of the engineers identified with the work expressed the opinion that it will actually run close to 70,000 cubic yards. The average highway, even in this mountainous section, involves only 30,000 to 40,000 cubic yards of excavation. Cuts range up to 45 and 50 feet in depth, and fills up to 55 and 60 feet in height.

The specifications for this contract provide that all fills shall be built up in horizontal layers of not more than a foot in thickness and that each layer shall be consolidated before another is placed on top of it. This clause not only insures the employment of a large number of men for spreading the material but also makes certain that the fills will be solidly packed upon completion and that the concrete can be laid upon them without the necessity of allowing time for settlement.

At the start, several of the contractors used trucks for hauling excavated materials; but the first storm after the commencement of operations demonstrated that other equipment would have to be employed instead. The surface soil is largely clay, and considerable of the material in the cuts is shale. Moisture renders both of these exceedingly slippery; and where grades are high and hillside sections are steep it is not possible to use wheeled vehicles with efficiency or even to keep them right side up. Accordingly, crawler-mounted equipment made its appearance for most of the hauling. Two general types are in service. The first, and least important, is locally known as the "iron mule," and consists of a 4-cubic-yard dump body on a crawler tractor. The second type, which is largely employed, is a separate dump body mounted on crawlers and drawn by a crawler-mounted tractor. Such "wagons," as they are designated, have a rated capacity of 8 cubic yards, and this is often increased to 10 cubic yards by heaping the material upon them. They are dumped by means of oil pistons which receive their pressure from a pump on the tractor.

Because it is virtually impossible to determine the character of the material beneath the surface without considerable exploratory work, no attempt was made to divide it into rock and common, and it was listed in the specifications as "unclassified." Contractors with West Virginia experience know full well, however, that from a third to a half of the material handled in highway construction will be rock, and they have learned to bid accordingly. In this instance, so it is estimated by a member of the state's engineering staff, the rock will amount to approximately 35 per cent of the total material excavated. This rock shows a wide variation over the 8-mile line; but, in general, it consists of limestone on the Bluefield end, sandstone on the Princeton end, and shale in the central zone.

Where hard material must be handled in such large quantities, and where the depth of cuts reaches such large proportions, it is vital to the success of a contractor that he choose drilling equipment that will meet the rigorous conditions so well that the rock can be broken up quickly and at a reasonable cost. This problem has been solved on the Bluefield-Princeton highway by the adoption of the wagon drill. This type of equipment has been used for years in quarrying and in line-drilling, but it has had only limited employment in roadbuilding. It remained for the contractors in West Virginia to discover its efficiency in construction work of this kind; and the results they have obtained with the wagon drill would seem to demonstrate that it merits the careful consideration of highway builders wherever rock work is involved.

The wagon drill consists essentially of a structural-steel guide frame for the drill mounted on one of various available forms of chassis. Improved equipment of this type for road jobs has been introduced recently by Ingersoll-Rand Company, and is in use on the work under discussion. This Class D wagon drill, as it is designated, is mounted on a 3-wheel steel chassis which permits keeping the weight of the entire assembly within reasonable limits and facilitates moving the drill during the course of the drilling without the delays that most contractors have come to believe are inescapably associated with mounted drills.

**Fill material is dumped "on the run" and spread by hand-shoveling.**

**A steam shovel loading shale in a deep cut and, above, laying drain pipe prior to grading.**

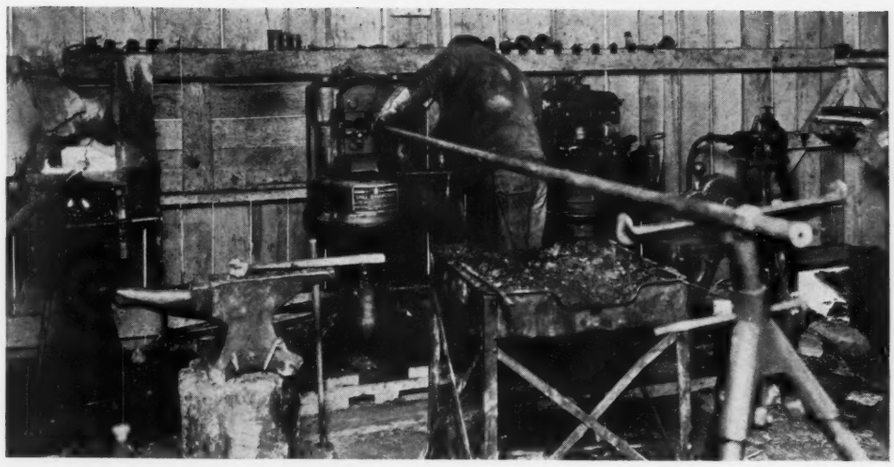
This form of drill is so responsive to quick handling that in several instances less than a minute was required to shift it to a new hole location while making a number of timed observations during the course of the project we are describing. For that matter, a one-day record of such a drill, while working on a road contract in this same general section of West Virginia last autumn, reveals that it was moved 140 times during a 10-hour shift. This means, of course, that it also put down 140 holes. On the following day, the same outfit was moved 97 times. The regular crew of two men—a driller and a helper—is able to get the drill over average ground without assistance.

The drilling member of the Class D is an Ingersoll-Rand X-71 drifter. This drill has been found to be best suited to the average rock conditions encountered in highway work. The drill is mounted on a slab-back. As some of the accompanying illustrations show, a "Utility" air hoist is provided for elevating the drill, thereby expediting the changing of steels and lightening the burden upon the workmen. An air hoist, hand hoist, or hand-operated tackle is used for extracting the drill steel from the hole and for raising the next steel and lowering it into the hole ready for drilling. An extension above the guide frame, surmounted by a steel hoop, holds the steels in an upright position and with their lower ends resting on a support on the chassis. They are thus moved with the rig when changing hole locations. At the base of the guide frame is an easily adjustable centralizer which limits the lateral movements of the bit to a restricted area and makes it possible quickly to start the hole in the exact position desired. The chassis is also completely piped for water and air connections.

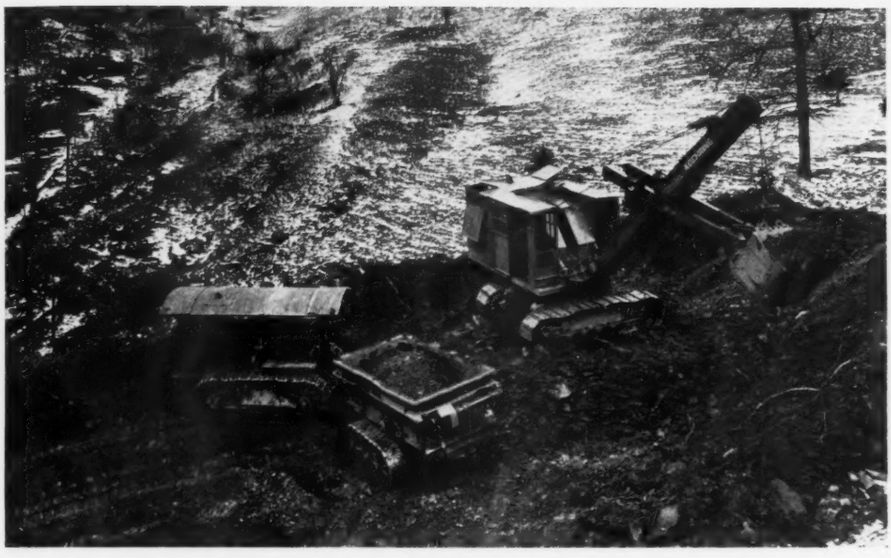
The advantages of this type of drill are many. Under almost any conditions where holes of considerable depth are to be placed, one wagon drill will do as much work as five "Jackhamers," and it will, moreover, satisfactorily penetrate ground in which "Jackhamers" can be used only with great difficulty or not at all. An outstanding example of this nature is the placing of holes in rock covered by a mantle of overburden. For satisfactory drilling results, it is almost always necessary to strip this overburden and expose the rock before attacking it with hand-held drills. The wagon drill, on the other hand, drills efficiently and quickly through the overburden. This effects a great saving in time and eliminates the cost of moving the top material. In rotten rock, in steeply dipping stratified rock, in ground that consists of alternate layers of rock and dirt, and under a variety of other conditions where there is a tendency for unconsolidated material to hamper or bind the drill steel, it is slow and tedious work to put down holes with light, hand-held drills. The wagon drill overcomes these difficulties. It is held solidly in the guide frame and cannot be wrenched from its position, as may happen where the operator's hands offer the only resistance to binding stresses. Its greater weight also serves to carry it rapidly through fractured ground in which the lighter drill can make but slow headway at the best. When one wagon drill supplants four or five "Jackhamers," there is a noteworthy saving in the items of wages, air consumption, and investment.

Three of the four contractors on the Bluefield-Princeton highway are using Class D wagon drills; and these units are proving of material benefit by enabling them to make fast progress regardless of the character of the ground in which they may find themselves from day to day. Little supplemental drilling is required after material is shot; but each contractor is equipped with lighter drills for handling such work as it arises. Predominant among these is the S-49 "Jackhamer."

On the section of the Bluefield-Princeton contract being handled by Patsy Small, Inc., a cut more than 40 feet deep was made through a hillside that consisted of a shale formation having an almost vertical dip. Initial operations demonstrated that this material could be excavated with a power shovel without blasting. The rate of progress was slow, however, and the wear and tear on the dipper teeth and upon the entire shovel mechanism was great. A Class D wagon drill was moved in and used to drill two rows of holes along the line of the cut, one near either edge—the holes in each row being spaced about 12 feet apart. The holes were loaded light with black powder and blasted, a few at a time, as the shovel approached them and needed material. As a result of this treatment, the ground was displaced but little, but was



Sharpening wagon-drill steel in the Rosenbaum Brothers blacksmith shop.



A view of the Marye & Blankenship work and, above, a wagon drill operating in dirt and rock.

so thoroughly shaken and loosened that the shovel was able to handle it as fast as if it had never been consolidated. The entire cut, involving the removal of about 40,000 cubic yards, was excavated with dispatch by following this procedure on successively lower levels of attack until grade line was reached.

In the kind of ground that we have been discussing—that is, in all material other than compact, solid rock—it is customary to use drill steel in which the central hole in the bit is forged closed and a hole is made in the side of the steel, at the bit, to connect with the central passageway. This is done to avert the plugging of the opening in the steel and the consequent stopping of the free flow of air to the bottom of the hole to keep it cleared of cuttings.

In well-consolidated material the wagon drill likewise offers distinct advantages. It takes 1¼-inch-section steel—larger than that used with "Jackhamers," and this permits the forging of larger starting bits. With a hand-held drill, steel changes must be made at each 2-foot deepening of the hole, at the most, for it is impossible for the average man conveniently to handle a drill if it be at a higher level than that for which this provides. The wagon drill, by contrast, uses 10-foot steel changes. These two factors—a larger starting bit and longer steel changes—enable it to bottom a deeper hole with a bigger diameter than can the "Jackhamer," and this, in turn, permits the employment of more explosive. As a result, holes can be spaced wider apart, and there is a consequent lessening in the total footage required effectively to break up the material for excavating. On the job under discussion, the general practice is to start a 30-foot hole with a 2¼-inch bit, which allows bottoming it with one of 2-inch size.

One of the important features of the wagon drill as compared with the hand-held drill is its independence of the human element. The pressure which a drill runner exerts on a drill varies widely from time to time; and probably during only a small part of the shift is it at the point of maximum efficiency. Then, too, a man tires towards the end of a shift, and there is a gradual but steady lessening of the pressure he applies. The wagon drill maintains a constant pressure as long as it is on the job, and that pressure can be definitely fixed at the most effective point for each of the many gradations of rock that may be met. The additional weight of the wagon drill and the tall guide frame fit it for putting down holes to a depth of 40 feet.

Compressed air for operating the drills is provided by portable units, there being six Ingersoll-Rand Type 20 machines on the four contracts. Five power shovels are in use by the contractors on the Bluefield-Princeton work. Patsy Small, Inc., is operating two steam machines, while each of the three others has one gasoline-engine unit in service. Their dipper capacities vary from 1 yard to 1½ yards.

A somewhat unusual condition was encountered at one point on the Small contract. Where the line crosses a ravine the ground was found to be swampy, and investigation revealed that the water was coming from springs. To insure stability of the right of way it was determined to excavate to a depth below the source of the water. Accordingly, a huge section, containing approximately 10,000 cubic yards of earth, is being dug out and disposed of, and the resulting excavation will be filled with fresh material.

At other points, where the highway passes over gulches, the fills are of such large size that adequate drainage must be provided to make sure that moisture will not exert harmful effects upon the built-up sections. In such areas, perforated corrugated-iron pipes are laid fanwise on the uphill side of the road to gather the ground water and to converge it toward the lowest point, where a pipe receives it and carries it under the fill. To give it a greater degree of permanence, this central drainage line is encased in concrete. This will insure the persistence of the waterway even after the metal section has corroded.

All in all, the work furnishes an interesting contrast in methods. Operations that can be done manually are so handled; but where mechanical agencies are used they are distinctive for their efficiency. Thus two divergent systems join hands.

The construction of the Bluefield-Princeton highway is under the direction of A. W. Paine, district engineer of the State Road Commission of West Virginia, whose headquarters are at Huntington. J. B. Crockett is serving as resident engineer in direct contact with the work.

Part of a 16-tool tie-tamper crew surfacing new track.

Some of the havoc wrought by the unruly, swollen stream.

# When Tehachapi Creek Turned Outlaw

LAWRENCE A. LUTHER

AUSTERE, slag-colored mountains and almost sterile plains make the Mohave Desert to the westbound traveler a vividly contrasting prelude to the miles of fragrant orange groves and other profusions of growth that he will encounter nearer the Pacific Coast. The few surviving forms of plant and animal life, existing sometimes for entire seasons without moisture from the sky, have become furtive and hard-bitten species of desert dwellers. To us of today it is almost incredible that there was a time, millions of years ago, when these furnacelike valleys were covered with seas. Yet the fact remains, and in proof of this we have the fossils of the aquatic creatures that abounded in those waters.

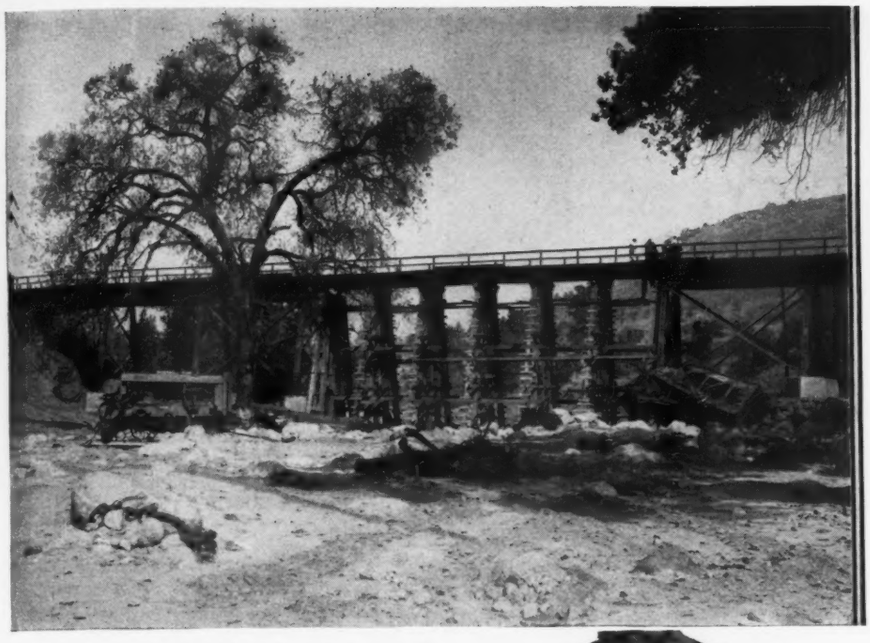
The possibility that the Tehachapi Range, a western wall of this hottest and most arid section of our Far West, should be devastated by a flood would appear to be remote. West winds bearing moisture from the Pacific relinquish a meager portion in crossing the Tehachapi ridges; but in average seasons these uplands do not have a rainfall sufficient to classify the area as well watered. Records of the United States Geological Survey covering a 37-year period give Tehachapi Summit a mean annual rainfall of 10.55 inches. The average rainfall for October has been less than ½ inch. A large portion of the annual precipitation usually is in the form of snow, and a fall of as much as 7 inches of rain in any one month is, indeed, a rare occurrence in the region.

When, in October, 1932, a total of 7 inches fell in 48 hours, with a peak performance of 2 inches in ½ hour, Tehachapi Creek proved wholly inadequate to serve its watershed. This creek—dry throughout most of the year—winds westward with a rapid fall through rugged canyons. Since the early days of the Spanish padres in California it had played its modest part in nature's scheme quite admirably; but this avalanche of water was enough to overflow a stream bed several times its size. Gathering such efficient battering rams as trees, automobiles, bowlders, and buildings, the flood readily demolished man-made structures of steel and concrete and gouged out for itself a wider and deeper channel. Oaks that were already sturdy trees when the American Revolution was in progress were uprooted and carried away by the torrent, and a number of lives were lost as the result of overconfidence bred of past storms.

The Tehachapi Mountain route, used jointly by the Southern Pacific and the Santa Fe, sustained damage amounting to $500,000. The railroad is one of California's pioneer lines. Built in 1875 by the Southern Pacific Company, it began immediately to take over the task of the covered wagon and brought many "first families" to southern California. George Westinghouse was just introducing his air brake on American railways; and the Tehachapi grades served, in effect, as a laboratory in thoroughly testing and developing what has since become a boon to transportation. The many thousands of passengers carried over the route during the present century without a case of serious injury is typical of modern railroading and testifies to the evolution of equipment, to the careful training and strict discipline of personnel, and to the tireless effort on the part of managements to insure safety. Although other forms of transportation may allure by reason of their novelty or speed, railway travel will doubtless continue for a long time to retain its premiership with respect to safety and comfort. When the Tehachapi line was built, California was in transition from a frontier, in which gold and adventure were the chief resources, to a young empire sustained by a more substantial foundation based on commerce and agriculture. Los Angeles was then little more than a dreamy village, more Spanish than Yankee in atmosphere, and no cult of super-realtors had as yet arisen to proclaim the charms of California's climate.

A main-line railway destroyed is a broken sinew in a nation's commercial organization; and this hamstringing of commerce occurred at that critical period when the harvesting of grapes and other perishable commodities was in full swing in the San Joaquin Valley. If a war had been in progress and this line of rail had been vital to the transport of troops and munitions, more zeal and ingenuity could not have been displayed by the Southern Pacific Company in the prosecution of its reconstruction program. Tehachapi Summit became, in effect, the eastern railhead, and Bena the western terminus. In the intervening distance of 35 miles, three viaducts and eleven bridges had been either severely damaged or destroyed, and some six miles of track required rebuilding—at certain points even relocating on new grade. One of the queerest incidents of this demonstration staged by capricious nature, and one typical of the havoc wrought, was the losing of a modern locomotive of the largest type. This massive engine had been completely buried under many feet of earth and was found by the aid of an electrical detector such as is used in prospecting for minerals.

Southern Pacific officials were not content with working from the two ends to close the gap. They assigned a complete organization to any point along the line, whether it was a bridge or a section of track, where it was at all possible to maintain transportation in handling the necessary supplies and materials. As many expert track and bridge men as were required were recruited from the various divisional organizations. Mr. W. H. Kirkbride, chief engineer of the Pacific system, with several members of his staff, lived on



**Above—A portable air compressor furnished power for woodworking tools during emergency repairs on a bridge.**

the job, and other officials devoted much time to the work. At intervals throughout the canyon, gangs of perspiring men labored in the flare of torches or floodlights all through the night. Pile drivers and steam shovels were kept on 24-hour duty; and work trains shuttled back and forth continually.

To remove debris, renew earth fills, and do other jobs in the reconstruction of a line after a storm is frequently just as hard as it was to do the work originally. A modern railroad does not consist merely of rails and ties: it also represents a heavy investment in appurtenant fixtures—signals with their complex relays and circuits; telephone and telegraph lines; and pipe lines carrying water for engines and often to supply stations and small towns along the right of way. The Southern Pacific was fortunate in having among its personnel men thoroughly familiar with the diverse problems involved. Few emergencies bring into relief greater *esprit de corps* than a washout on a railway. In opening the line to traffic two weeks after the cloudburst had swept the region, according to those that had seen the extent of the havoc wrought, the Southern Pacific accomplished the seemingly impossible.

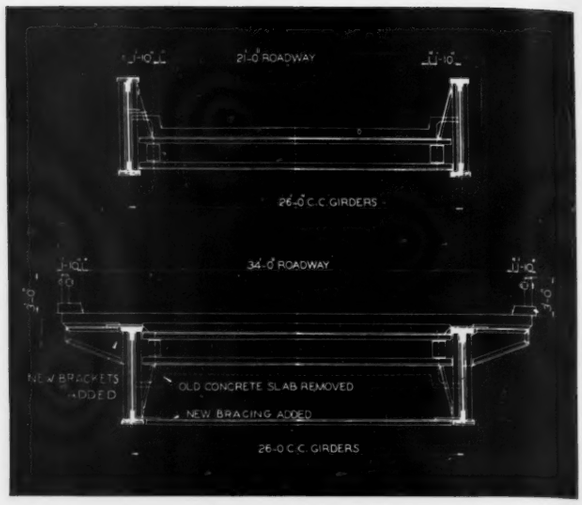
Compressed-air equipment played only a minor part in the reconstruction program; but one incident will emphasize the adaptability of the portable compressor in railway service. One of the gangs mobilized for the job was engaged in surfacing track near Colton; and to meet contingencies the foreman had been instructed to include a portable among his equipment. When a stratum of rock was encountered in excavating for a line change, this 310-cubic-foot unit was immediately assigned to 24-hour duty in supplying air to a number of "Jackhamers." Several such compressors had been purchased by the road in 1929 expressly to operate combinations of sixteen tie tampers—the first 16-tool units to be used in this country. Their work on the track, however, has not been restricted to resurfacing: they have also effected marked economies when employed in connection with pneumatic tools utilized in laying rail on an extensive scale and in excavating rock and when providing air for a multiplicity of tasks in building bridges and other structures.

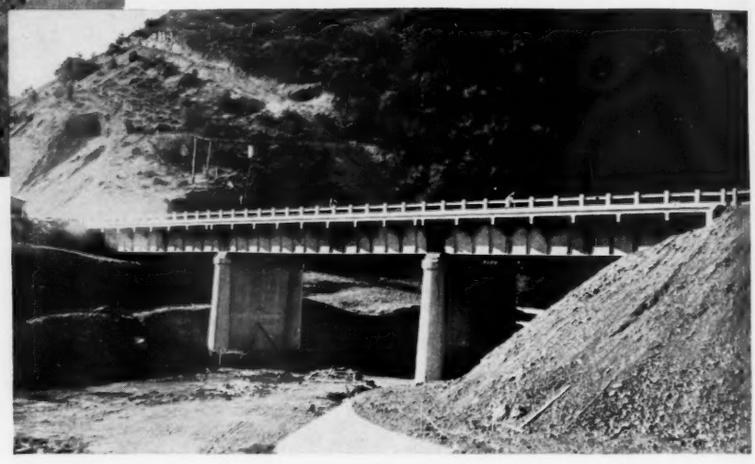
Storms sometimes work havoc with flying machines; but the airways require neither repair nor maintenance. We must all, in one form or another, pay assessments to cover the costs of repairing damage done to our motor highways by storms; but railroads must fall back on their private purses—not always overfull—in meeting such exigencies.

**Center—A pneumatic wrench speedily and effectively loosens or tightens nuts on rail-joint bolts.**

**Bottom—The big locomotive that came a cropper in the rocky bed of the stream.**

# Bridge Builders Give Lesson in Economy





**Above—Abandoned Castaic Creek Bridge which was demolished so that its girders could be used in the construction of a bridge that was required elsewhere on the relocated road.**

**Right—The same girders but an entirely different structure. In the Los Alamos Creek Bridge the girders are turned upside down so as to provide a roadway of ample width.**

**Right, top—Cross sections of the two bridges, showing the difference in design made possible by reversing the position of the girders.**

Courtesy California Highways and Public Works

IT may be "stylish to be thrifty," as a large department store advertises, but it has certainly become the order of the day in this time of necessity, and rightly so. Thrift is good business; and putting old materials that have served their primary purpose to use again comes under this category. Such materials must, however, be sound, especially if they are to be combined with new in any way. Economy of this sort was recently practiced with satisfactory results by the California Bridge Department when it undertook the demolition of an abandoned bridge, its removal to a new site, and its reconstruction there. An interesting angle of this work is that the new structure in no wise resembles the original one—in fact, is the old bridge literally turned upside down. This is plainly to be seen in the accompanying illustrations.

The new bridge is but one of seven that are on the Ridge Route between Los Angeles and Bakersfield that has been relocated so as to avoid sharp curves and steep grades and to make the run between those points shorter and safer for motor traffic. The structure has a length of about 220 feet and spans Los Alamos Creek near Bakersfield. At the other end of the highway, in the vicinity of Los Angeles, a bridge had become useless because of a change in the right of way, and it just so happened that the girders in that particular structure were of the requisite length and of the kind specified for the Los Alamos Creek crossing. They were 80 feet long, and of the through type—that is, they flanked a 21-foot concrete roadway and served as railing. Upon examination they were found to be in excellent condition, and the question was: "Would it be the part of economy to tear down the bridge for the sake of three of its six girders?" Investigations revealed that the expense would be justified, and the work was promptly taken in hand. It was no small job, especially as care had to be taken not to damage the structural steel.

Air-operated hammers were employed in removing the concrete because they could be counted upon to do the work quickly and satisfactorily. Girders, floor beams, and bracing were held together by 4,500 rivets, and these, too, were removed by the aid of pneumatic tools. After the bridge had been razed it was necessary to cut the girders at the splices, for they were too long in their original state for transportation by trucks and trailers over the highways—the traffic laws of California requiring that a vehicle plus its load shall not exceed 75 feet in length.

Before the reclaimed girders could be erected on the piers and abutments at the new site they had to undergo a measure of refabrication. New steel plates and angles were added to form brackets and braces; and 1,300 holes were sunk and rivets driven to bind the parts together. The old bearing shoes that had been on the bottom when the girders spanned Castaic Creek were now fastened on top. When the building operations were finished, the structural steel was thoroughly cleaned, sand blasted, and given three coats of paint, and in this work compressed air was again helpful. The reconstructed bridge has a concrete deck 34 feet wide with curbs of concrete and rails of redwood.

The Ridge Route project, of which the job we have just described is but a minor phase, is said to be one of the largest and most spectacular road-relocation contracts that has ever been undertaken by the California Department of Highways. By eliminating curves, easing grades, and otherwise changing the highway, the distance between Los Angeles and Bakersfield has been shortened by almost ten miles, and motorists will, as a consequence, save annually in operating and power costs an estimated sum of $1,259,000.

## JAMES H. JOWETT

WE regretfully report the death of James Henry Jowett, executive vice-president of Ingersoll-Rand Company, 11 Broadway, New York City. Mr. Jowett died in Flower Hospital, New York, on February 16, after an illness of four months. He was 58 years old, having been born September 15, 1874, at Cleveland, Ohio. His parents were James and Mary Pond Jowett.

Mr. Jowett spent virtually his entire adult life with the Ingersoll-Rand organization, and was one of the leading personalities in its development. Energy, thoroughness, and fair-mindedness were his outstanding attributes, and they earned for him an enviable reputation as a keen and capable executive. They likewise won for him the respect and admiration of his associates.

Following courses in the Cleveland public schools and the Cleveland Manual Training School, he became a draftsman for the old Tom Johnson Steel Company, at Johnstown, Pa. He left there in 1893 to enter the employ of the Ingersoll-Sergeant Drill Company, which was later consolidated with the Rand Drill Company to form the Ingersoll-Rand Company. The firm was then located at 27th Street and Ninth Avenue, New York City. A year later he was transferred to Easton, Pa., where a new plant had been erected. As a draftsman and engineer, Mr. Jowett's early training gave him a wide knowledge of the design and construction of the company's products, which provided a foundation for his subsequent success as a salesman and executive.

After a few years at Easton, he turned his attention to the commercial side of the business, going to New York to become a member of the force of the branch sales office there. He soon made evident his aptitude for this work, and rose quickly to manager of the office. Under his direction the New York sales office grew increasingly important as an outlet for the company's products. During that period much important engineering and construction work was carried out in New York, including the installation, from 1900 to 1904, of the first unit in the metropolitan subway system.

He was promoted to the position of assistant general sales manager and then to general sales manager. From there he was elevated to executive vice-president and was made a member of the board of directors. At the time of his death, he was also on the directorates of the A. S. Cameron Steam Pump Works and of the Rathbun-Jones Engineering Corporation.

Mr. Jowett was intimately acquainted with all phases of his company's activities, but he was most interested in rock-drilling equipment. He was familiar with drilling conditions and problems in various parts of the world; and was considered a competent authority on rock drills and their application. In his sales and executive capacities he had much to do with extending the range of his company's activities into all sections of the world.

James Henry Jowett

We repeat here a tribute paid him shortly after his death by an associate of long standing: "Mr. Jowett was gifted with exceptional ability and vision in dealing with all matters pertaining to the rock drill and to the compressed-air and hydraulic industries. His sales and executive ability was of a high order—in fact, of such a nature that his decisions were never questioned by his men, as they invariably turned out to be correct.

"He was an exceptionally hard worker and a stern, impressive master, but he had the cardinal attribute of being always fair. His subordinates loved him not only for his ability and perception but also because he was known to be an incessant fighter for his own men and absolutely fair and square in his treatment of them."

Mr. Jowett was a member of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, as well as of the following organizations in New York: The Engineers Club, Racquet and Tennis Club, Union League Club, India House, and Downtown Association. He also belonged to the Wykagyl Country Club.

The family home was at 303 West 91st Street, where he lived with his wife, Mrs. Genevieve Elder Jowett, and his daughter, Miss Lucille Jowett. Other surviving relatives are a sister, Mrs. Alfred Griffor, and two brothers, William E. and Charles Edward Jowett, all of Cleveland.

Funeral services were held February 18 at All Angels' Church in New York City. Burial was in the family plot in the Easton Cemetery, Easton, Pa.

## ICE HELPS BRIDGE BUILDER SURMOUNT DIFFICULTY

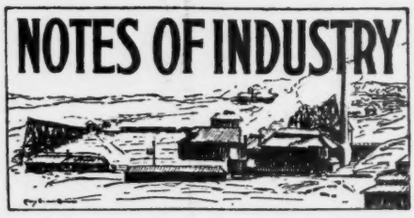
ICE can be very helpful for purposes other than refrigeration, and this was exemplified not so long ago in the case of a bridge job which suddenly presented a problem that had not been foreseen but that was solved, as has just been intimated, by the use of frozen water. Ice is every now and then made to serve in a kindred capacity; but the present application is interesting and worth describing.

In erecting the 61-ton steel span of the Russian River Bridge on the Tahoe-Ukiah cut-off highway in California, the trusses were tied together on the approaches by transverse floor beams and rolled, in three separate sections, over the completed trestle spans to their respective positions, where they were supported by falsework. So held, the several sections were riveted together; cribbing was placed on the concrete piers under the two end floor beams; and the falsework removed, leaving the span 3½ feet above its final grade. By the aid of jacks the steelwork was then lowered; but when it got to within 6 inches of its resting place it was discovered that the jacks could no longer be used because there was not enough clearance between the beams and the piers. And here is where the ice comes in.

From a local ice company were ordered six 400-pound cakes of ice, each measuring approximately 10½x21x56 inches, to be delivered at 6:30 a.m. the following day. These blocks were laid with the flat side down in groups of three on the piers and directly beneath the end floor beams. To better distribute the load, timber planking was inserted between the ice and the relatively narrow flanges of the beams. With this done, the entire weight of the structure was transferred from the jacks to the ice. Twenty-five hours elapsed before the ice had melted sufficiently to bring the span down the remaining 6 inches, and in that interval the builders were able to place the pedestals and rockers and to do the other necessary work. It was noted that the relative decrease in the length, width, and thickness of the ice was about in direct proportion to the areas that determined the size of block to be used.

Each 400-pound cake had to bear a load of 20,000 pounds, or 50 times its own weight. This left a large margin of safety, as laboratory tests on 8-inch cubes showed ordinary commercial ice to have a compressive strength of about 220 pounds per square inch. Allowing a safety factor of two, this would seem to indicate that each block, placed flatways, could have carried an additional burden of 110,000 pounds, or 130,000 pounds in all.

# NOTES OF INDUSTRY



We are told that it takes two rubber trees two years to supply enough latex to make one automobile tire.

By annexing 82 villages and towns, the City of Tokio has increased her population from 2,000,000 to 5,000,000, making Tokio the largest industrial center in Japan.

The buildings of the World's Exposition to be held in Chicago this year are, so report has it, to be heated with natural gas that is to be piped from the Panhandle District of Texas.

Steelwork in pickling departments can, it is claimed, be protected against acid fumes and other destructive agencies by a new liquid that has a mineral base. The coating can be applied to either hot or cold surfaces by a spray gun.

Each of the six mines in the Logan Division of the West Virginia Coal & Coke Corporation is equipped with a portable compressor that is installed primarily to supply air for cleaning mine locomotives. This work is done at the end of each shift by the locomotive runner.

After several years of experimenting, the German Beryllium Research Society has announced the development of a process that is said to effect a considerable reduction in the cost of producing that metal. It is the price of beryllium that has so far stood in the way of a more extensive use of it in alloys.

An improvement in air sprays for marking traffic lanes is announced by Spraco, Inc., Somerville, Mass. The gun is mounted between adjustable disks so that it can paint a strip varying in width from 3 to 10 inches. The outfit is easily portable, and is accompanied by a truck on which are mounted a small compressor and paint tanks.

A new valve has been developed by the Hills-McCanna Company of Chicago, Ill., for handling air, volatile substances, hot or cold water, solids in suspension, and a long list of corrosive liquids. In this valve the fluids are at no time brought in contact with the bonnet or the working parts, and no stuffing box is required. It is available in any commercial material, and with either a glass or rubber lining.

A very thin veneer of wood on a paper backing is the latest thing in "wall paper" in Germany. It comes in oak, maple, satin and American walnut, pearwood, cherry, and in two species of mahogany, and can be applied like ordinary wall paper with rye meal. If hung properly it will not warp nor crack. The new wall paper is said to possess certain insulating properties and to have the appearance of wood paneling.

An air cylinder is proving an effective shock absorber and silencer on a pedal-operated riveting machine. The arrangement is such that air is admitted to the cylinder chamber on the down stroke of the head, which corresponds to the upward movement of the piston, and compressed on the up stroke of the head. While being acted upon by the piston, some of this air escapes through a small port which, however, is closed at a definite stage in the operating cycle so as to permit just enough to remain in the chamber to effectually cushion the blow.

Great Britain, Canada, and the Irish Free State have under advisement the development of a big seaport and airport at Galway to expedite passenger and mail service between Canada and all parts of Europe and beyond. The plans for the project have been prepared by Sir John Griffiths, a former president of the Institution of Civil Engineers, in cooperation with his son, Mr. John Griffiths, and involve the construction of a new harbor at Galway, on the west coast of Ireland, and of an airplane field in keeping with it on the outskirts of the town.

Airplane-refueling trucks for flying-field service have been built for the United States Army Air Corps by the Columbia Steel Tank Company, Kansas City, Mo. Twelve of these trucks, designed by the Army Quartermaster Department, are now in use. Each unit is 30 feet long, and is equipped with tanks carrying, respectively, 1,500 gallons of gasoline, 100 gallons of oil, 50 gallons of water, and compressed air, which is used for braking purposes and to inflate both the truck and the airplane tires. Refueling is done by pumps powered by take-off from the regular drive shaft of the 130-hp. truck motor.

From "Brought Forward" by H. M. Bateman

**The man who worked through his lunch hour rather than disappoint his public.**

Pure iron, according to *Steel*, is being made in Germany by a new process which is said to be applicable on a large scale. Carbon monoxide is passed over purified hot iron and unites with the metal to form iron carbonyl, a liquid of relatively low boiling point. When heat is applied to this liquid it expels the carbon and oxygen, leaving particles of iron about twenty-millionths of an inch in diameter. When this powder is subjected to a temperature of 2,192° F., the iron solidifies and resembles copper in its softness, resistance to corrosion, and other properties.

Rubber belting designed primarily for endless splicing right on a machine is the latest product of the B. F. Goodrich Company, Akron, Ohio. "Highflex Junior", the name under which the new belting is being sold, is built up of a large number of plies of a specially woven fabric and comes in widths of 6 inches and under. The equipment and materials required to do the splicing consist, besides some hand tools, of a light template for laying out and stepping down the ends of the belt to insure a good fit, of a portable electric vulcanizer, and of a special cement and tie gum that are said to make a tight and lasting joint.

Trucks and hopper cars with bodies of aluminum are appearing here and there in industry for the hauling of bulk commodities such as ore, coal, etc. The Alcoa Ore Company, of Pittsburgh, Pa., has ten 70-ton aluminum hopper cars in service—the saving in weight in the case of each being 21,200 pounds. A coal and coke dealer in Providence, R. I., has increased the capacity of each of his trucks close on to 1 ton by cutting down the weight of the body from 4,250 pounds to 2,650 pounds by the use of aluminum. The United States Bureau of Mines also is operating six automobile dumping trucks with bodies built entirely of aluminum. This metal, because of its lightness, strength, and resistance to corrosion lends itself well to the work of transportation.

According to a contract lately awarded to the Carrier Engineering Corporation, the new 70-story RCA Building in Rockefeller Center, New York City, will house the largest single air-conditioning system in the world. An idea of its magnitude can be obtained if we are told that it will be able, in extremely hot weather, to absorb from the atmosphere within the walls of the structure approximately 18,000,000 B.t.u's, or enough heat to keep 400 families, living in homes of average size, comfortable throughout an entire winter. The system will deliver about 400,000 cubic feet of conditioned air a minute to maintain a mean temperature of 70° F. in winter and a maximum of 85° in summer. For the distribution of this air will be required nearly fifteen miles of ducts. The installation will represent an expenditure of more than $1,000,000.